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Health Systems Efficiency after the Crisis in the OECD

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Abstract

This work evaluates the efficiency position of the health system of each OECD country. It identifies whether, or not, health systems changed in terms of quality and performance after the financial crisis. The health systems performance was calculated by fixed-effects estimator and by stochastic frontier analysis. The results suggest that many of those countries that the crisis affected the most are more efficient than the OECD average. In addition, some of those countries even managed to reach the top decile in the efficiency ranking. Finally, we analyze the stochastic frontier efficiency scores together with other health indicators to evaluate the health systems' overall adjustments derived from the crisis.

Keywords: Health Systems Efficiency, Health in the OECD, Impact of Financial crisis, Life Expectancy Determinants

I. Introduction

The impact of the 2008 crisis on health care has heightened the need to make appropriate investment in health quality and to reinforce financial sustainability of the health care systems. Of particular interest is the health care systems efficiency and health care restructurings and improvements in order to cope with the impact of the economic crisis.

Health systems efficiency has been studied for a period before the crisis by Joumard et al. (2010). They found that in the OECD countries higher health care expenditures did not necessarily mean better health status. There was indeed efficiency shortage in some countries. Based on the results, recommendations for improvements were specified for each country's health system.

However, it is not clear whether the budgetary constraints and health reforms resulting from the crisis changed those findings.

The purpose of this research is to analyze how health systems efficiency in the OECD countries have adjusted after the crisis. Answering the main question will imply evaluating the recent relative position of each country in the OECD health system efficiency ranking. An analysis similar to Joumard et al. (2010) was done using 2005-2011 data, for 33 OECD countries. Moreover, it is important to observe in which aspects health care systems are doing better and in which they are doing worse than before 2008, so that weaknesses that prevent a better performance can be identified.

The results show that several countries changed their efficiency score after the crisis. Some of those countries that the crisis affected the most increased their relative position in the efficiency ranking. Moreover, the results show that if all countries improve the system performance to the level of the most efficient county, the OECD average life expectancy at birth of total population can increase by almost two years.

This paper is structured in the following way. Section II presents some previous empirical work in assessing health care systems efficiency, section III describes the methodology and data which is used. Then, the health status determinants, the efficiency results as measured by both fixed-effects estimator and stochastic frontier approaches, the health indicators comparison by groups of countries and the change on the health care profile of each country are presented in section IV. Finally, we present work limitations and conclusions in section V.

II. Literature Review

As the main objective is to have a direct comparison with the work of Joumard et al. (2008, 2010), these studies are the starting point. They calculated health care systems efficiency scores of 30 OECD countries by two methods: fixed-effects estimator, over the period of 1981-2003, and data envelopment analysis, using data for 2007. They found that on average, OECD countries could increase life expectancy at birth by 2 years if all became as efficiency as the best performer. The efficiency scores were compared with other health indicators, particularly with those reflecting the activity and quality of the health care system.

By cluster analysis, countries were grouped, in 6 groups, based on their health care system's characteristics in the form of several indicators transformed from the answers of 29 countries to the OECD Survey on Health Systems Characteristics 2009. So that, all health indicators would be analyzed by comparing each country not only with the OECD average, but also with its group of countries with similar health system characteristics. It was also found that there was no health system type considerably better than the others. The efficiency level had a higher variance within each group than between groups.

There has been a great focus in the literature on assessing health efficiency at national

and international system level, as well as at hospital level within countries, by taking different approaches. The Canadian Institute for Health Information (2014) also measured the health care efficiency and its determinants for the different regions in Canada using data envelopment analysis. And they found that there were regional differences in performance and that by maximizing their efficiency, regions could on average reduce treatable causes of death by 18% to 35%. They also found that less smoking, obesity and chronic conditions, shorter lengths of stay, more equity in health access and more primary care investment have significant impact on regional efficiency. Alternative approaches to measure performance of health care have been taken in other studies. WHO (2000) and Evans et al. (2000) studied the health care system efficiency of 191 countries for 1997, by a stochastic frontier analysis, taking the Disability-Adjusted Life Expectancy as health status of the population. Murray and Evans (2003) pointed out that the stochastic frontier analysis is more appropriate in efficiency measurement than the data envelopment analysis, since the latter method attributes all the distance to the frontier as inefficiency, not taking into account random factors.

Jourmard et al. (2008) created a health production function and found that health spending is the factor that affects the most the health status of a population, followed by education. They found that a 10% increase in health spending increases life expectancy at birth by 3 to 4 months, keeping everything else constant. On the other hand, Thornton (2002) presented empirical evidence for the USA that socioeconomic status, such as education, income and married households have more impact on the health status of the country, in this case, age-adjusted death rate, than health spending.

III. Data and Methodology

Given that it was not feasible to use the exact same variables as in Joumard et al. (2008, 2010), there is one modification in the production function's input, one lifestyle variable

was removed from the original model of Joumard et al (2008, 2010). The efficiency was estimated by two approaches: 1) regressions using panel data and estimated by fixed-effects and 2) stochastic frontier analysis, SFA (as opposed to data envelopment analysis that was used in the above-mentioned literature). Moreover, three OECD countries, Estonia, Israel and Slovenia were not analyzed by Joumard et al. (2008, 2010), but they are included in this paper.

Similarly to the work of Joumard et al. (2010), the efficiency scores were analyzed together with those indicators that reflect the quality of preventive and out-patient care sectors (vaccination, avoidable hospital admission and acute myocardial infarction and stroke fatality rates), the hospital output efficiency (in-patient average length of stays, acute care occupancy and turnover rates, cataract surgeries and consultations per doctor), equity in health status, amenable mortality rates (those deaths due to causes that could potentially be avoided with the effective treatment at the right time) and administration costs, which are useful to assess the health system efficiency of each country. Other indicators included in the country profiles are related to health care prices and spending per capita and to GDP, number of health professionals and their respective income, hospital physical resources (high-tech equipment and hospital beds), hospital activity (doctor consultations per capita, hospital discharges and some surgery procedures), pharmaceutical consumption, nature of health care financing (public, private insurance, out-of-pocket) and spending destination sectors (in-patient, out-patient, medical goods). All these indicators (Table 1) were not considered as inputs in the health production function, because these indicators are hospital's output-based efficiency indicators. Yet they are a complement in the study of the system (outcome-based) efficiency determinants.

Although most indicators were retrieved from the OECD Health Data, some had to be

developed by calculations for this paper. For comparison purposes, the same proxy for health status equity was calculated as in Joumard et al. (2010), by the inverse of the standard deviation in the age of death for population aged above 10, using data on number of deaths by age from the Human Mortality Database. This age dispersion was proposed by Edwards and Tuljapurkar (2005) as a proxy for health inequalities in health status. An output efficiency indicator, the acute care turnover rate, was also calculated, by dividing the number of acute discharges by the number or available acute care beds.

Table 1 - Health care indicators by area

<table>
<tr><th colspan="2">Efficiency and quality</th><th>Amenable mortality</th></tr>
<tr><td colspan="2">• SFA efficiency score
• Equity score
• Average length of stay
o All in-patient; Colorectal cancer; Lung cancer; Breast cancer; Acute myocardial infarction; Femur fracture
• Acute occupancy rate
• Acute turnover rate
• Cataract surgery
• Consultations per doctor
• Expenditure in health administration
• Vaccination rates
o Diphtheria, tetanus and pertussis; Measles; Influenza
• Avoidable hospital admission rates
o Asthma; Bronchitis; Heart Failure
• In-hospital case fatality rates
o Acute myocardial Infarction; Ischemic stroke</td><td>• All causes
• Infectious diseases
• Cancers
• Endocrine, nutritional and metabolic diseases
• Diseases of nervous system
• Diseases of circulatory system
• Diseases of genitor-urinary system
• Diseases of respiratory system
• Diseases of digestive system
• Perinatal mortality</td></tr>
<tr><th>Prices and physical resources</th><th>Activity and consumption</th><th>Financing and spending</th></tr>
<tr><td>• Total health expenditure
• Practicing physicians
• Practicing nurses
• Medical graduates
• MRI units
• Computed tomography scanners
• Number of acute care beds
• Remuneration of hospital nurses
• Remuneration of general practitioners
• Remuneration of specialists
• Relative health prices to GDP</td><td>• Doctor consultations
• Hospital discharges
• Hip replacement
• Knee replacement
• Appendectomy
• Caesareans sections
• Antidepressants
• Anxiolytics
• Analgesics
• Anti-inflammatory, antirheumatism
• Antibacterials for systemic use
• Cardiovascular system
• Drugs for diabetes</td><td>• Public spending
• General government funding
• Social security funding
• Private health insurance funding
• Out-of-pocket payments
• Expenditure on medical goods
• Expenditure on out-patient care
• Expenditure on in-patient
• Expenditure on collective services (public health services and health administration)</td></tr>
</table>

Source: Joumard at al. (2010)

To calculate the efficiency of the health systems, a production function was designed for the health care at the system level.

The production function's output and input data were retrieved from OECD Health Data 2014. A panel data covering 7 years was analyzed, focusing in the time between 2005

and 2011, for the majority of the variables. The purpose was to get as many years before as after the financial crisis of 2008.

As the output at the system level, life expectancy at birth, for females, males and both, and life expectancy at age 65 for each gender were the variables used as proxy for the health status of each countries' population. Life expectancy at birth for both genders was considered the dependent variable for the efficiency calculations, by both fixed-effects estimator and stochastic frontier approaches. Other proxies could be thought as more desirable as one assumes that it is important to take into account the quality of life of the population (Joumard et al., 2008). However, regarding all possible health status indicators, longevity data was the most complete one.

Health status depends on the quantity of medical care services that is offered to the population, thus the variable used as its proxy was total health expenditure per capita US$ PPP rates. Moreover, the health care that the population receive over the years also influence the current health status. Therefore, a variable with the cumulative value of health investment was also considered as a variable of health stock of the previous three years. It has been debatable whether a discount rate for healthcare should be taken into account, and at what value (Acharya and Murray, 2003; Stahl, 2004), therefore the ad-hoc discount rate of 10% was chosen.

Two population's lifestyle indicators (alcohol and diet) were used as control variables in the fixed-effects estimator. Alcohol consumption in liters per capita was introduced as a 1-year lag variable, as the current level of alcohol consumption may have an impact in health status, but alcohol data for all countries is only complete until 2010. A proxy for diet, consumption of fruits and vegetables in kilograms was also taken into account in the production functions.

It would be appropriate to include a variable of tobacco consumption, however it was

not possible to do it since ten of the thirty-four OECD countries could not be analyzed. Data for tobacco consumption in grams per capita is nonexistent for Chile, Estonia, Luxembourg, Mexico, Slovakia and Slovenia and is missing for several other countries, either in recent years or in lagged values. Other alternative measures of tobacco consumption (e.g. share of daily smokers; number of cigarettes smoked per day) also present missing data for many countries.

The exogenous variables' set also included one environmental factor affecting population's health: emissions of nitrogen oxide in kilograms per capita. This factor represents air pollution in each country which especially affects the respiratory system, and so may affect life expectancy.

Education and income are the two socioeconomic variables taken into account in the models. The education variable is measured by the share of adult population with at least upper secondary school. Income is measured by the GDP per capita US$ PPP rate.

The regressions by fixed-effects estimator were the first approach used to calculate the efficiency ranking,[1] allowing for a direct comparison with Joumard et al. (2008, 2010). And were also the main approach used to verify the impact of health expenditure on the health status of the population of each country, while controlling for other lifestyle and socioeconomic variables (alcohol consumption, diet, pollution, education and GDP). Life expectancy at birth for females, males and both, and life expectancy at age of 65 for females and males were the dependent variables for the analysis of impact of each independent variable. However, to get the efficiency score only life expectancy at birth for total population was taken as the dependent variable. Moreover, all variables included in the regressions were transformed in logarithms.

The assumption of this method by fixed-effects estimator is that what is not accounted

[1] Cameron, A. Colin, and Pravin K. Trivedi. (2005). "Linear Panel Models: Basics" *Microeconometrics: methods and applications*, 697-726. Cambridge University Press.

for by the model reflects the health care system efficiency of the country (Joumard et al., 2008). This efficiency score was calculated by adding up the country fixed-effects to the residuals of the latest year in study. This sum measures the distance to the production frontier. Thus, it was assumed that the country fixed-effects are part of the country inefficiency, and are not revealing a different production frontier for each country.

The alternative methodology of this paper to calculate the inefficiency score is the Stochastic Frontier Analysis (SFA).[2] The frontier is the maximum outcome (health status) that is possible to reach given the level of inputs in use. This method allows to make the distinction between the part of the residual that is due to random factors and the part of the residual that accounts for the country inefficiency. The production function used was the same one as in the regressions with fixed-effects estimator referred above. The same output and inputs transformed in logarithms were included. Modeling the production frontier with panel data increases the number of observations and accuracy of estimates. This way, it is feasible to calculate the system inefficiency by analyzing the frontier with country fixed-effects incorporated into the inefficiency equation, which is compatible with the previous approach by fixed-effects estimator. Besides, with a stochastic frontier model using fixed-effects there is no need to make any assumptions about the inefficiency term's distribution, which makes this method less restrictive (Murray and Evans, 2003).

Although the efficiency was calculated for 2011 by both methods, there were two exceptions that had different latest years available: for Korea and Mexico the score was calculated for 2010 and 2008, respectively.

[2] Coelli, Timothy J., D.S. Prasada Rao, Christopher J. O'Donnell, and George E. Battese. (2005). "Stochastic Frontier Analysis". *An introduction to efficiency and productivity analysis*, 141-61. New York: Springer.

For Chile, education data is missing for 2005 and 2006 and data of nitrogen oxide emissions is missing for the rest of the studied years, therefore it is the only OECD country not being analyzed here.

In this work it was assumed as reasonable to compare efficiency scores and other health indicators within and across the group of countries with similar health care system characteristics that are resulting from the Survey on Health Systems Characteristics 2008-2009 analysis made by Joumard et al. (2010). Although there is some new data for countries' health policy and institutions, from the Survey on Health Systems Characteristics 2012, this data was not as complete. More recently, other authors (e.g. Pisu, 2014 and Tchicaya and Lorentz, 2014) analyzed health care sectors and systems using the indicators of system characteristics that result from Joumard et al. (2010) and other data from the Survey on Health Systems Characteristics 2008-2009.

IV. Results

The economic crisis in mid-2008 had a visible impact on the OECD average health spending per capita, US$ PPP. On average the health spending growth decreased after 2008, especially between 2009 and 2010 when the average growth rate was close to zero. However, some countries actually decreased their total health spending per capita after the crisis, namely Czech Republic, Estonia, Greece, Iceland, Ireland, Portugal, Slovak Republic, Slovenia, Spain, Turkey and United Kingdom. Some of those still had negative health spending growth in 2011: Greece, Ireland, Portugal, Slovak Republic and Spain (Morgan and Astolfi, 2014).

Now we know how the main health sector input evolved, therefore it is important to understand the impact of this and other non-health sector inputs on the health status, as well as, what happened to the efficiency of these countries individually.

IV.1 Health status determinants

The presented regressions' output resulted from fixed-effect estimator with robust

standard errors.[3]

Table 2 indicates that a country has higher life expectancy at birth of total population if it spends more in health care, has more adults with at least upper secondary education and less air pollution. These coefficients are statistically significant, at the 1% or 5% level, for life expectancy at birth of total population, i.e. for both female and male.

Table 2 – Fixed-effects estimator output: Health status determinants

	Female birth b/se	Male birth b/se	Total birth b/se	Female65 b/se	Male65 b/se
logSpending	0.024**	0.036*	0.030**	0.064**	0.089***
	(0.01)	(0.02)	(0.01)	(0.02)	(0.03)
logAlcohol	-0.014	-0.027*	-0.021	-0.042	-0.060
	(0.01)	(0.02)	(0.01)	(0.03)	(0.04)
logDiet	-0.004	-0.003	-0.003	-0.016	-0.014
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
logEdu	0.045***	0.033***	0.039***	0.136***	0.088***
	(0.01)	(0.01)	(0.01)	(0.04)	(0.03)
logNOx	-0.010	-0.018*	-0.013*	-0.048**	-0.069***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
logGDP	0.015*	0.014	0.014	0.039*	0.043
	(0.01)	(0.02)	(0.01)	(0.02)	(0.03)
constant	3.952***	3.898***	3.923***	1.859***	1.727***
	(0.06)	(0.06)	(0.05)	(0.22)	(0.25)
R-sqr	0.798	0.785	0.807	0.802	0.825
N	225	225	225	225	225

* p<0.10, ** p<0.05, *** p<0.01

The variables' coefficients in the regressions have the expected signs. The exception is the coefficient for diet, consumption of fruits and vegetables, which has a negative impact in health status. However its impact is not statistically significant.

In this period of 2005-2011, the regressions output reveal that for total population income per capita and the lifestyle variables, alcohol and fruits and vegetables consumption, are not significantly different from zero and that education is the variable with the highest elasticity. This may be due to higher education meaning more access to health information and a better understanding of it by the patients which may have impact on the efficacy of medical services (Thornton, 2002). Nevertheless, the OECD

[3] There may be some endogeneity effect, as the level of total healthcare expenditure is a function of the income level. Table A.2 in appendix shows that by excluding the variable of GDP in the fixed-effects estimator regressions, the coefficient of health spending increases, suggesting that the variable of spending includes the income effect not related to health, which may lead to biased estimators. For this reason and for the lack of reliable instrumental variables, Joumard et al. (2008) included both health spending and GDP variables in their model. In this paper, we also included them for comparison reasons.

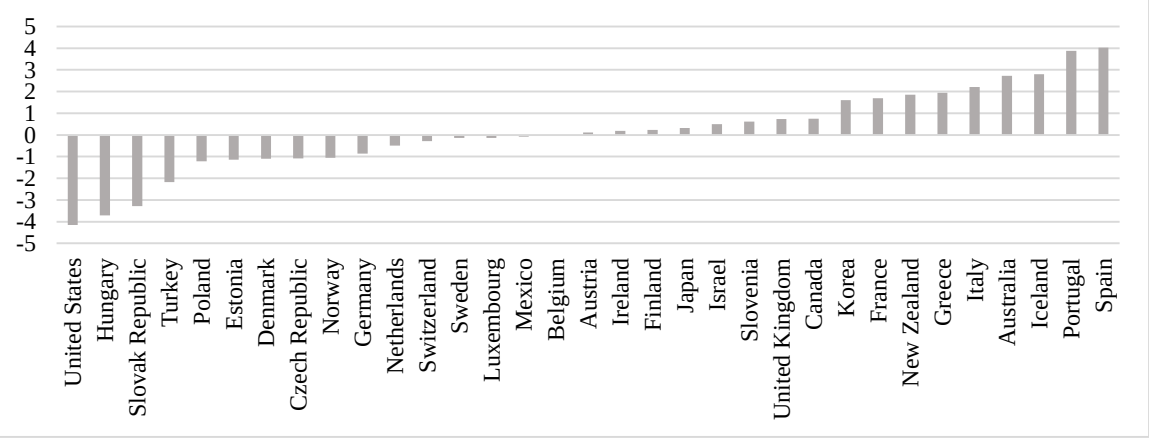
average of life expectancy at birth of total population may increase 2.86 months if the average spending increases by 10%, keeping everything else constant.

Table A.3 in appendix presents another specification of the model including a variable of health stock. However, the stock of investment in health is highly correlated with the current health spending (Table A.4 in appendix). Thus, the variable of health stock was not included in the main model of efficiency measure.

IV.2 Fixed-effects estimator – Efficiency ranking

By taking life expectancy at birth for total population as the dependent variable, the fixed-effects and the residuals specify the years of life gained or lost compared to those years of life expectancy that were expected if the country had the same efficiency as the OECD average. Which means that, by these assumptions, Austria has the average efficiency, while Spain's high efficiency allows it to get 4 more years compared to the (average) output that was expected by the model. On the other hand, the United States of America is the OECD country with the least efficient healthcare system, according to the fixed-effects estimator method, losing 4 years of life expectancy compared to the expected output. Figure 1 presents these deviations in years of life expectancy at birth for total population, resulting in the ranking of countries' health system efficiency.

Figure 1 - Country fixed-effects and residuals deviation from OECD average, 2011: Years of life expectancy not accounted for by the model (Fixed-effects estimator)

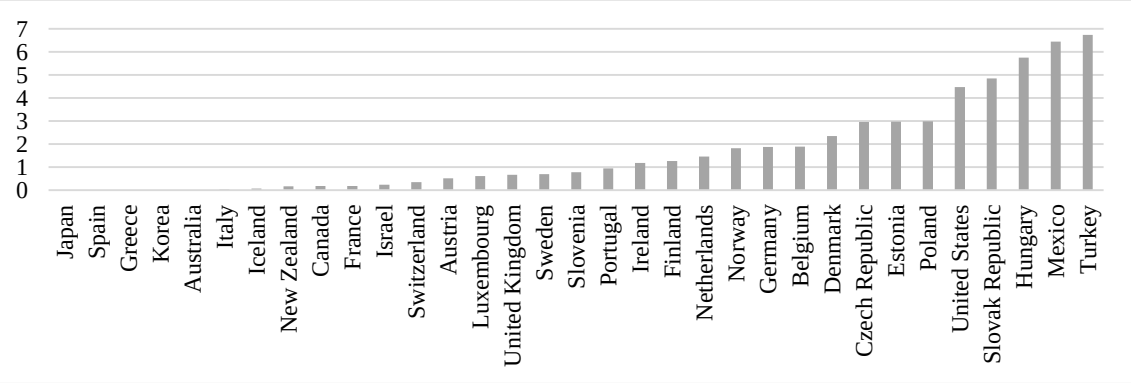


Comparatively to the 2003 efficiency results from Jourmard et al. (2008, 2010), measured by fixed-effects estimator under the same assumptions (Figure A.1 in appendix), it is possible to notice that, for 2011, there were some changes on the relative position of this efficiency ranking. The results displayed in Figure 1 indicate that, taking into account only those 23 countries studied by fixed-effects estimator in Joumard et al. (2008, 2010), Poland and Sweden went down considerably in the ranking, while United Kingdom and Austria became more efficient than the average.

IV.3 Stochastic Frontier Analysis – Efficiency scores

By the second method, the stochastic frontier analysis, the resulting inefficiency scores were converted into years of life expectancy that the country can potentially gain if it increases its efficiency to the level determined by the frontier (Table A.5 in appendix shows the SFA coefficients). By incorporating country fixed-effects into the model, typically one or more countries are in the frontier and assumed as being totally efficient, while the other countries are analyzed by comparison to those efficient ones (Kumbhakar and Lovell, 2000).

Figure 2 - Potential gains in years of life expectancy (Stochastic Frontier Analysis)

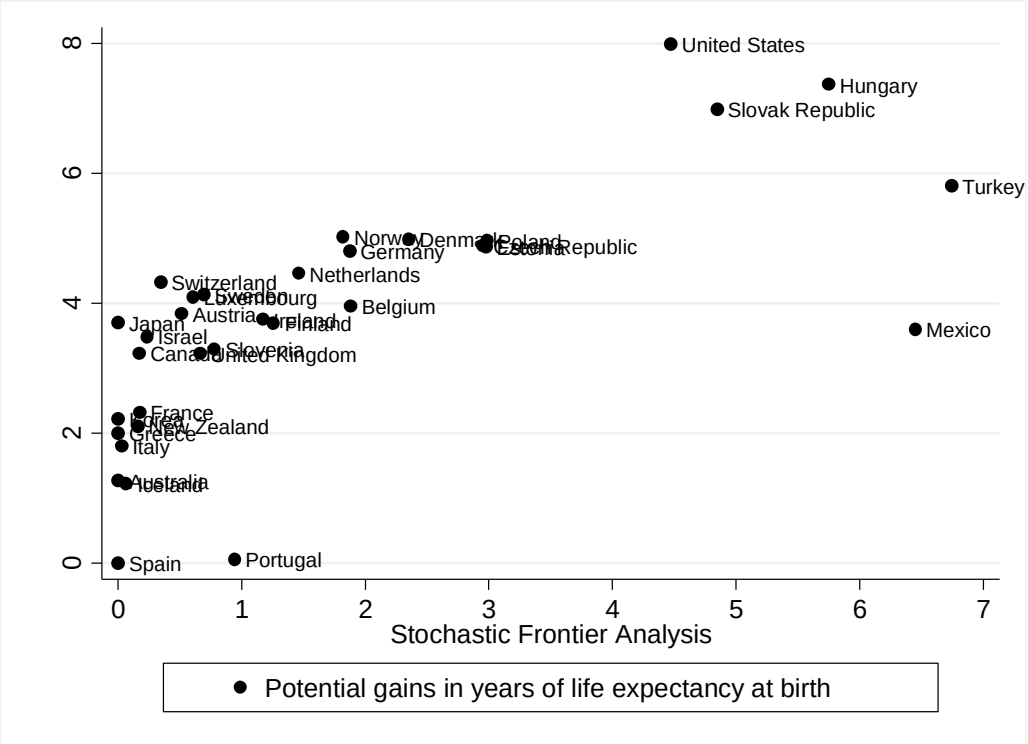


In this case, the countries that are completely efficient are, Japan, Spain, Greece, Korea and Australia, their observed output is placed on the production frontier. While Turkey, Mexico and Hungary could increase their total population life expectancy at birth by approximately 6 years if they were as efficient as the most efficient countries.

IV.4 Fixed-effects estimator vs Stochastic frontier

For the calculations of the potential gains in life expectancy by both methods, the reference is the most efficient country. These scores result from comparing each country with the most efficient one.

Figure 3 - Potential gains in years of life expectancy at birth: Fixed-effects estimator and Stochastic Frontier analysis plot



Although there are some changes on efficiency ranking places, the results are similar in terms of which countries are the most efficient ones and which ones are the least efficient (Figure 3). However, the maximum number of years a country can potentially increase its life expectancy is 1 year lower by the stochastic frontier method than by the fixed-effects estimator method. Additionally, by the stochastic frontier analysis, the potential gains of life expectancy at birth are, on average, 1 years and 8 months, but by the fixed-effects estimator, the average potential gains is 3 years and 8 months.

From those countries with negative health spending growth in 2011, Spain, Portugal, Greece and Ireland have above OECD average efficiency, while Slovak Republic is the only one which has below average efficiency, as measured by both efficiency

approaches.

IV.5 Changes within and across groups

From those six groups of countries with similar health systems characteristics resulting from the work of Joumard et al. (2010),[4] the same analysis comparing efficiency scores, as measured by the stochastic frontier, within and between groups was done. The analysis showed that there are efficient and inefficient countries (above and below OECD average efficiency) in every group (Figure 4). Moreover, as presented in Table 3, the number of years of life expectancy a country could gain by increasing its efficiency to the frontier level has higher variance within groups than between groups. These conclusions correspond to the results for 2007, from Joumard et al. (2010), emphasizing once again that no health system type has necessarily better performance than the others.

From the 2011 results in Figure 4 and Table 3, it is possible to compare the 2007 results, presented in Figure A.2 in appendix, from similar work done by Jourmard et al. (2010). Yet, some OECD countries which efficiency was analyzed for 2011, can still not be included in the analysis of this section. This is the case of Estonia, Israel, Slovenia and United States of America, since they did not participate in the Survey on Health Systems Characteristics 2008-2009, therefore it was not possible to group them for their health system characteristics like the other countries.

Within group 1 (Germany, Netherlands, Slovak Republic, Switzerland), only the

[4] Group 1 is composed by countries that rely on market mechanisms at the provider level and a high share of private basic insurance.
Group 2 is composed by countries that rely on market mechanisms at the provider level, public basic insurance, private over-the-basic insurance and gate-keeping.
Group 3 is composed by countries that rely on market mechanisms at provider level, public basic insurance, little private over-the-basic insurance and no gate-keeping.
Group 4 is composed by countries that rely mostly on public provision and insurance, no gate keeping and wide choice of providers.
Group 5 is composed by countries that rely on public provision and public insurance, gate-keeping, limited choice of providers and soft budget constraint.
Group 6 is composed by countries that rely on public provision and insurance, gate-keeping, wide choice of providers and strict budget constraint. (Joumard et al., 2010)

Netherlands' efficiency score shifted to above average, but the group mean efficiency after the crisis is still worse than the OECD average. Switzerland still has the highest efficiency, while the least efficient country is represented by Slovak Republic.

Figure 4 - Potential gains in life expectancy at birth across and within country groups plot (Stochastic Frontier Analysis)

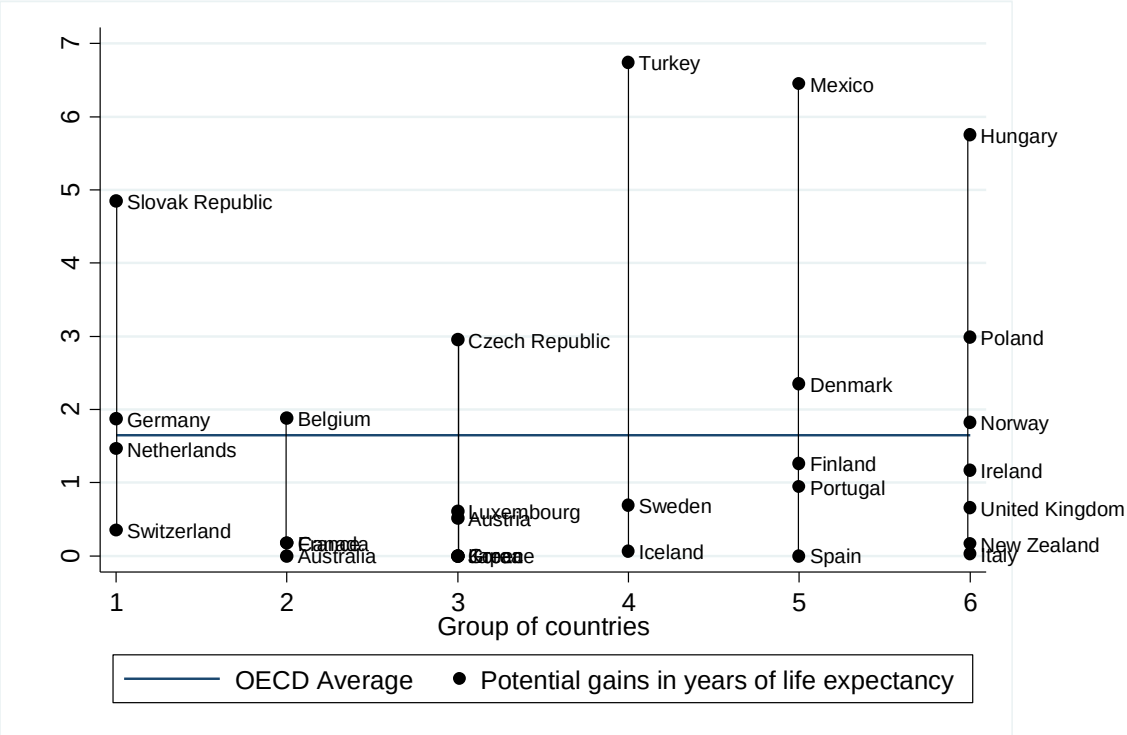


Table 3 - Potential gains in life expectancy at birth within and across groups: mean and variance (Stochastic Frontier Analysis)

Group of countries with similar system characterisitics	Potential gains in years of life expectancy	
	Mean	Variance
1: Germany, Netherlands, Slovak Republic, Switzerland	2,1	3,7
2: Australia, Belgium, Canada, France	0,6	0,8
3: Austria, Czech Republic, Greece, Japan, Korea, Luxembourg	0,7	1,3
4: Iceland, Sweeden, Turkey	2,5	13,6
5: Denmark, Finland, Mexico, Portugal, Spain	2,2	6,4
6: Hungary, Ireland, Italy, New Zealand, Norway, Poland, United Kingdom	1,8	4,1
Total	1,6	3,9
Intra-group	-	4,4
Inter-group	-	0,5

Group 2 (Australia, Belgium, Canada, France) has seen some small changes where Canada and France improved their performance and are now in quite high and very close relative positions. Yet, Australia and Belgium are still the most and the least

efficient countries, respectively. This group keeps having a better mean performance than the OECD average and has now the highest performance among the groups.

The third group (Austria, Czech Republic, Greece, Japan, Korea, Luxembourg) had efficiency improvements in general, especially the major increase of Greece's efficiency, that in 2011 is the highest of the group together with Japan and Korea. Austria is also performing well and Luxembourg improved and is now very close to Austria's efficiency level. The worst performer of this group is now Czech Republic that keeps below average after the crisis.

The forth group, composed by Iceland, Sweden and Turkey, had the highest mean efficiency, in 2007. However, it has now a lower mean efficiency and is the group with the highest score variance. Iceland and Sweden continue performing well, however after the crisis, Turkey had a great decrease of performance and goes from the highest to the lowest efficiency score of this group.

Concerning group 5 (Denmark, Finland, Mexico, Portugal, Spain), Spain and Portugal continue to have high efficiency levels and Finland has improved its performance since 2007. Denmark is still performing below the OECD average. Mexico has the most extreme change of position as it goes from being the most efficient country to the least efficient one of the fifth group. This leads to a low group mean efficiency.

The countries of group 6 (Hungary, Ireland, Italy, New Zealand, Norway, Poland, United Kingdom) are still performing worse than the OECD average. Although Italy and Hungary continue being the highest and the lowest performers, respectively, there were some shifts in this group after the crisis. In 2011, Ireland, United Kingdom and New Zealand have above average scores, while Norway and Poland are performing worse than before.

Taking the stochastic frontier efficiency scores of each country into account and

comparing them with the OECD average and with the previous results measured by data envelopment analysis (Figure A.2 in the appendix) from Jourmard et al. (2010), it is possible to verify that, after the crisis, most of those countries with high or low efficiency keep similar relative positions. Moreover, Spain and Italy became even more efficient than in 2007. Nevertheless, some other countries changed from their inefficient situation and became more efficient than the average, namely Greece, Ireland, New Zealand, Austria, Finland, Netherlands Luxembourg and United Kingdom. While Mexico, Turkey, Poland and Norway decreased their position and became inefficient.

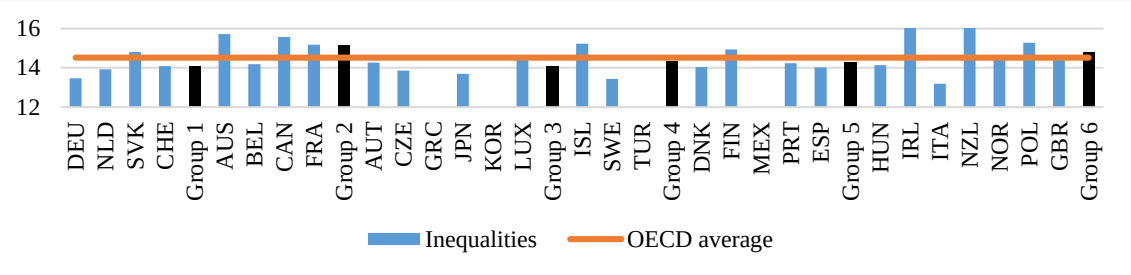
IV.6 Other health indicators – group comparison

On average, the inequalities in health status, measured by the standard deviation of the age of death for population aged above 10, increased almost 1 standard deviation after the crisis (Figure 5). The group with the lowest average of inequalities is now group 1, composed by Germany, Netherlands, Slovak Republic and Switzerland. While group 2 still has on average the highest level of inequalities. Comparatively to 2007, there were some changes within groups. In group 1, the country with the highest level of inequalities continues to be Slovak Republic, however the one with the lowest level is now Germany. In 2011, group 2 has Australia as the country with the most inequalities and Belgium with the lowest. In group 3, Luxembourg became the country with the highest inequalities, however, Japan passed from having the highest level to the lowest of the group. In group 4 it is now possible to notice the highest within group variation, between the high level of inequalities of Iceland and the low level of Sweden. Group 5 appears as the only group without changes in inequalities ranking. While in the sixth group, Italy keeps having the lowest inequality levels, but Ireland became the country with the highest level.

In 2011, the OECD average life expectancy at birth is 80 years (Figure 6). With the exception of group 2, which is only composed by countries with life expectancy that is

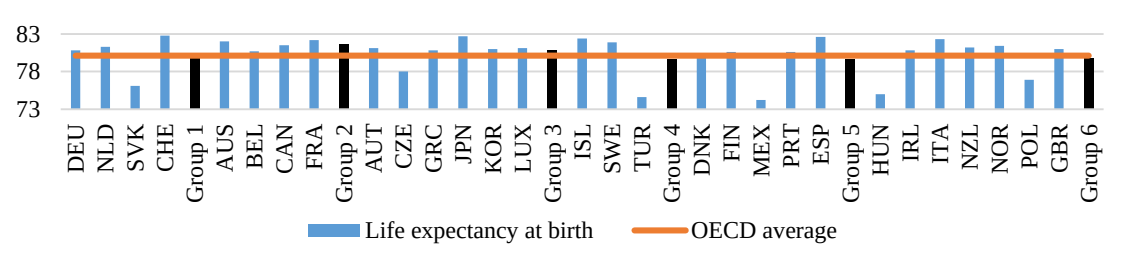
higher than the OECD average, every group have wide within variations, since they include countries with both above and below average life expectancy.

Figure 5 - Inequalities in health status across country groups of health system characteristics, 2011 (or latest year available)



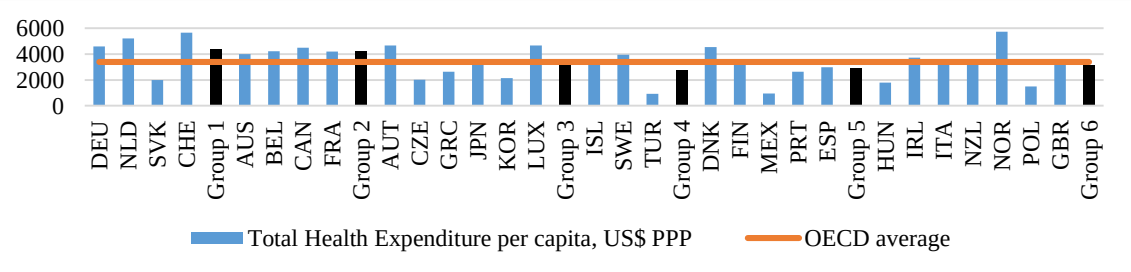
Source: Human Mortality Database.

Figure 6 - Total population life expectancy at birth across country groups of health system characteristics, 2011 (or latest year available)



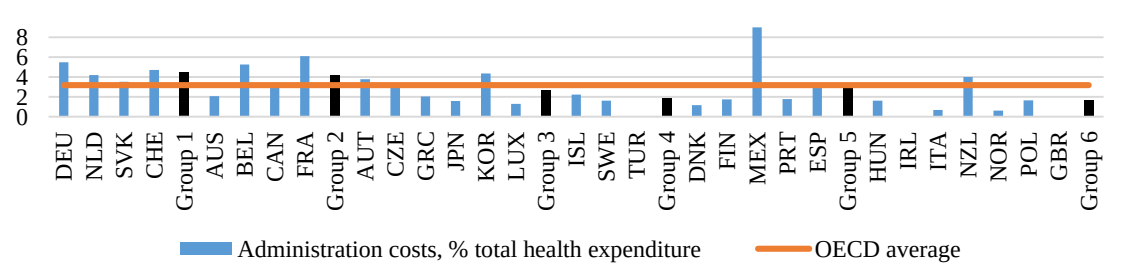
Source: OECD Health Data 2014.

Figure 7 - Total Health expenditure per capita, US$ PPP across country groups of health system characteristics, 2011 (or latest year available)



Source: OECD Health Data 2014.

Figure 8 - Administrative costs across county groups of health system characteristics, 2011 (or latest year available)



Source: OECD Health Data 2014.

Total health expenditure per capita continues to be higher on average in groups 1 and 2. The forth group has the lowest spending on average, with contribution of Iceland's great health expenditure decrease in 2010 (Figure 7).

In general, in 2011 the OECD average administrative costs in percentage of total health spending decreased. The countries that in 2007 had this percentage much higher than the average decreased it considerably after the crisis. For instance, Luxembourg had the second highest percentage of administration costs before, however, it is now among the countries with the lowest percentage (Figure 8).

IV.7 Health indicators comparison between 2007 and 2011

To complement the countries' profile, the stochastic frontier efficiency scores were analyzed together with other health indicators. In this section, we compare the recent levels of the health indicators with those 2007 levels studied by Joumard et al. (2010).

In Table 4, we compare each country against the OECD average, pointing out the main changes occurring after the crisis. Some of the recommendations presented in the previously referred work were taken into account to verify whether they were followed by the countries or not. Moreover, we present the potential total health savings per capita, US$ PPP, for the countries that are not totally efficient. The potential health savings were estimated by the change on health spending that leads the country to the efficiency frontier, keeping the same life expectancy level and the other inputs constant. The health care indicators are divided by areas, the same ones as those in Joumard et al. (2010): efficiency and quality; amenable mortality; health prices and physical resources; activity and consumption; financing and spending.

Besides a high efficiency score, one would consider the ideal health care system as the one having low inequalities in health status, low amenable mortality rates, low administrative costs, short average length of stay, high quality of service provision, an appropriate number of health professionals for the level of health demand and a

balanced share of resources between sectors.

Table 4 – Main changes on countries' profile and potential health savings per capita

Country (SFA Rank)	**Efficiency and quality; Amenable mortality**	**Prices and physical resources**	**Activity and consumption**	**Financing and spending**	**Previous recommendations status; Potential total health savings/ capita (US$ PPP)[5]**
Australia (5)	High efficiency; Higher inequalities; Shorter in-patient stays; Mixed quality	More doctors, nurses and medical students; Lower prices	More hospital discharges		Achieved: - Reducing length of stay of in-patient care
Austria (13)	Higher efficiency; Longer stays; More consultations/ doctor	Higher prices	Low pharmaceuticals consumption/ capita	Higher spending share on out-patient care	Not achieved: - Increasing quality Not totally achieved: - Rebalancing in-patient and out-patient resources Potential savings: 1198.15$ (25.7% of health spending)
Belgium (24)	Low efficiency; Less inequalities; More consultations/ doctor	Less doctors and nurses; Higher income of health professionals			Not achieved: - Increase hospital efficiency; - Reducing number of doctor consultations; - Reducing administrative costs Potential savings: 2782.79$ (65.8% of health spending)
Canada (9)	High efficiency; High inequalities;		More consultations/ capita; Low pharmaceuticals consumption		Not achieved: - Reducing inequalities
Czech Republic (26)	Low efficiency; Lower amenable mortality; Long stays	More students; Above average income of general practitioners		Higher spending on out-patient care	Not achieved: - Reducing number of doctor consultations; - Improving quality Potential savings: 1667.58$ (82.2% of health spending)
Denmark (25)	Low efficiency; Less consultations/ doctor; Less inequalities	More scanners High income of general practitioners	Less consultations/ capita		Achieved: - Decreasing the excessive demand to general practitioners Potential savings: 3358.31$ (73.9% of health spending)
Estonia (27)	Low efficiency; Low equity; Low amenable mortality; Low hospital efficiency; Low quality of care	Few human and physical resources; Very low remuneration of health professionals	Low hospital activity; Low pharmaceuticals consumption	Low spending on in-patient; High spending on out-patient and on medical goods	Potential savings: 1126.79$ (83% of health spending)
Finland (20)	Higher efficiency; Lower amenable mortality; Low in-patient efficiency	More medical students			Achieved: - Increasing spending share on out-patient care Not achieved: - Decreasing inequalities; - Improving out-patient care quality

[5] Due to the low elasticity (spending coefficient), small measurement errors, long-term effects of health spending and low total variation in life expectancy may have huge impact in the potential savings. This might explain partly why we may get high values of potential savings.

Country (SFA Rank)	Efficiency and quality; Amenable mortality	Prices and physical resources	Activity and consumption	Financing and spending	Previous recommendations status; Potential total health savings/ capita (US$ PPP)[5]
					Potential savings: 1777.20$ (51.4% of health spending)
France (10)	High efficiency; Higher amenable mortality; Shorter stays	Low remuneration of health professionals	Higher pharmaceuticals consumption		Not achieved: - Decreasing health status inequalities; - Reducing administrative costs
Germany (23)	Low efficiency; High equity; Higher amenable mortality; More consultations/ doctor, but lower hospital efficiency		More consultations/ capita		Not achieved: - Adjusting policies to avoid excessive hospital activity Potential savings: 3023.68$ (65.6% of health spending)
Greece (3)	Higher efficiency; Lower amenable mortality; Low administrative costs		Few consultations/ capita; More hospital discharges	Higher spending on in-patient care; Low spending on out-patient care	
Hungary (31)	Low efficiency; Less inequalities; Lower amenable mortality; Low hospital efficiency				Achieved: - Decreasing inequalities Not achieved: - Rebalancing resources from medical goods to in-patient and out-patient care Potential savings: 1744.54$ (96.9% of health spending)
Iceland (7)	High efficiency; More inequalities; Short stays; Lower preventive care quality	Lower remuneration of nurses and general practitioners		Lower spending to GDP; More spending on medical goods and on out-patient care	Not achieved: - Control health care spending; - Reducing spending on in-patient care; - Reducing number of human resources and increase quality of care
Ireland (19)	Higher efficiency; More inequalities; Lower amenable mortality	Less doctors; Higher income of nurses	Few consultations/ capita	Lower public spending	Potential savings: 1830.69$ (48.9% of health spending)
Israel (11)	High efficiency; Low equity; Low amenable mortality; Rather high hospital efficiency	Few physical resources; More doctors; High income of nurses; Low health prices		High private health insurance and out-of-pocket financing	Potential savings: 198.82$ (9% of health spending)
Italy (6)	High efficiency; Higher amenable mortality; Rather low hospital efficiency	Below average remuneration of nurses and specialist			Not achieved: - Improving efficiency on the in-patient care sector Potential savings: 6.17$ (0.19% of health spending)
Japan (1)	High efficiency; Higher amenable mortality; High equity;			Higher spending to GDP	Not achieved: - Reducing length of stays in acute and in-patient care; - Reducing number of doctor

Country (SFA Rank)	Efficiency and quality; Amenable mortality	Prices and physical resources	Activity and consumption	Financing and spending	Previous recommendations status; Potential total health savings/ capita (US$ PPP)[5]
	Higher preventive care quality				consultations Partially achieved: - Improving quality Potential savings: 490.47$ (14.2% of health spending)
Korea (4)	High efficiency; Higher preventive care quality				Not achieved: - Reducing the number of doctor consultations
Luxembourg (14)	Higher efficiency; Mixed quality; Lower administrative costs				Not achieved: - Improving in-patient care efficiency; - Increasing out-of-pocket payments Achieved: - Reducing administrative costs Potential savings: 1353.62$ (29% of health spending)
Mexico (32)	Lower efficiency; High amenable mortality; Short stays; Rather low quality of care	Lower prices	Few hospital discharges	Lower spending on medical goods; Very low spending on in-patient care	Not achieved: - Improving health status of the population; - Reducing administrative costs Potential savings: 861.82$ (98.3% of health spending)
Netherlands (21)	Average efficiency				Potential savings: 2937.78$ (56.3% of health spending)
New Zealand (8)	Higher efficiency	Less hospital beds; Higher income of specialists	Less consultations/ capita		Not achieved: - Reducing inequalities; - Reducing high administrative costs; - Improving hospital efficiency Potential savings: 313.51$ (9.9% of health spending)
Norway (22)	Lower efficiency; Few consultations/ doctor	Less nurses	Few consultations/ capita		Not achieved: - Reducing number of doctors for the needs of the population Potential savings: 3695.81$ (64.3% of health spending)
Poland (28)	Lower efficiency; Lower amenable mortality; Longer stays;	Below average remuneration of health professionals	Less hospital discharges		Not achieved: - Decreasing inequalities; - Increasing hospital efficiency; - Increasing quality of care Potential savings: 1239.46$ (82.9% of health spending)
Portugal (18)	High efficiency; Less inequalities; Lower amenable mortality	More medical students/ capita		Lower public spending	Not achieved: - Improving efficiency of in-patient sector; - Increasing number of consultations/ doctor; - Improving quality of care Potential savings: 1102.35$ (41.7% of health spending)
Slovak Republic (30)	Low efficiency; Lower amenable mortality; Rather low quality of care				Not achieved: - Increase remuneration of health professionals to increase quality of care Potential savings: 1888.70$ (94.5% of health spending)
Slovenia (17)	High efficiency; High equity; Low amenable	Few human and physical resources;	Low health spending/ capita; More hospital	High social and private insurance;	Potential savings: 928.23$ (36.3% of health spending)

Country (SFA Rank)	Efficiency and quality; Amenable mortality	Prices and physical resources	Activity and consumption	Financing and spending	Previous recommendations status; Potential total health savings/ capita (US$ PPP)[5]
	mortality	Low health prices; High income of general practitioners	discharges; Low pharmaceuticals consumption	High spending share on in-patient and medical goods	
Spain (2)	High efficiency; Rather high amenable mortality; More administrative costs	Higher health prices; High income of nurses			Not achieved: - Improving hospital efficiency
Sweden (16)	High efficiency; Higher preventive care quality	Less medical students			Partially achieved: - Improving quality Not achieved: - Reducing number of doctors for the low number of doctor consultations Potential savings: 1318.64$ (33.3% of health spending)
Switzerland (12)	High efficiency; High administrative costs	Lower health care prices			Achieved: - Containing health care prices Potential savings: 852.24$ (15% of health spending)
Turkey (33)	Lower efficiency; High amenable mortality; Mixed quality	High remuneration of health professionals	More consultations/ capita; More hospital discharges	Higher public spending	Not achieved: - Containing level of public health spending Potential savings: 921.09$ (98.3% of health spending)
United Kingdom (15)	Higher efficiency; Higher amenable mortality	Lower remuneration of general practitioners	High pharmaceuticals consumption		Not achieved: - Improving quality Potential savings: 1016.29$ (31.6% of health spending)
United States of America (29)	Low efficiency; Very high amenable mortality; High administrative costs	More high-tech equipment	Very high spending/ capita; Less consultations and discharges/ capita	High private insurance financing; Low spending on out-patient care	Potential savings: 7842.58$ (92.5% of health spending)

Source: OECD Health Data 2014; Human Mortality Database; Joumard et al. (2010)

V. Conclusions and Limitations

The levels of adult education and of health expenditure are highly associated with the health status of the population. Keeping everything else constant, a ten percent increase on the OECD average of total health expenditure increases life expectancy at birth of total population by almost 3 months, on average.

The economic crisis has appeared for many countries as a challenge for the health care system. The crisis required budget controls in most countries, while keeping and/or

increasing the same level of quality and coverage of health care services. Therefore, the crisis was an opportunity to create reforms that changed several health care systems efficiency. Six OECD countries, Greece, Ireland, Austria, New Zealand, United Kingdom, Finland, Netherlands and Luxembourg increased their position relative to the average, while four countries, Norway, Poland, Mexico and Turkey decreased it. Southern European countries, like Spain and Greece, economies where the crisis had a great socioeconomic impact and where expenditure controls were essential, show up as countries that reached the top health care system efficiency. Although, these countries decreased the total health spending per capita after the crisis, there was no immediate effect on the health status of their population. Nevertheless, if all countries increase their efficiency to the efficiency level of the best performer, the OECD average life expectancy at birth of total population can still increase by almost two years.

However, the non-inclusion of tobacco consumption, due to lack of data, on the health production function can have some efficiency implications. This can be especially challenging in the fixed-effects estimator approach, since the assumption of including the residuals in the efficiency score disregards the possibility of measurement errors or other random factors.

Moreover, both methods of efficiency calculation, imply the comparison of the countries to the best performing country. Though, the best health system derived from the calculations does not necessarily have the best achievable performance in theory. This means that the efficiency scores are overestimated and the top performer can improve and reach even higher levels of efficiency and quality in the health care.

However, higher accessibility of health data, namely lifestyle and quality indicators would improve the precision of the estimates and allow a better understanding of countries' weaknesses.

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Health Systems Efficiency after the Crisis in the OECD

Appendix

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Table A.1 – Definition of the health indicators

Efficiency and quality indicators	**Definition**
SFA efficiency score	The inefficiency translated in years of life expectancy, resulting from the stochastic frontier analysis with one output (life expectancy at birth) and six inputs (health spending, alcohol consumption, diet, education, pollution and income).
Equity score	The inverse of the standard deviation of the age of death for population aged above 10
Average length of stay – All, in-patient	The ratio between number of bed-days and number of discharges
Average length of stay – Colorectal cancer	The ratio between number of bed-days and number of discharges – cases of malignant neoplasm of colon, rectum and anus
Average length of stay – Lung cancer	The ratio between number of bed-days and number of discharges – cases of Malignant neoplasm of trachea, bronchus and lung
Average length of stay – Breast cancer	The ratio between number of bed-days and number of discharges – cases of malignant neoplasm of breast
Average length of stay – Acute myocardial infarction	The ratio between number of bed-days and number of discharges – cases of acute myocardial infarction
Average length of stay – Femur fracture	The ratio between number of bed-days and number of discharges – cases of fracture of femur
Acute occupancy rate	Percentage of the curative care beds that are occupied
Acute turnover rate	The ratio between number of acute discharges and the number of available acute care beds
Cataract surgery	Total number of surgical procedures
Consultations per doctor	Number of consultations per doctor
Expenditure in health administration	Percentage of the total health expenditure that is addressed to administrative cost
Vaccination rates – Diphtheria, tetanus and pertussis	Percentage of children immunized against diphtheria, tetanus and pertussis
Vaccination rates – Measles	Percentage of children immunized against measles
Vaccination rates – Influenza	Percentage of population aged 65 and over immunized against influenza
Avoidable hospital admission rates – Asthma	Hospital admission rates for cases of asthma of population aged 15 and over. (These admissions are considered avoidable, because it is assumed that most asthma cases could be handled without hospitalization.)
Avoidable hospital admission rates – Bronchitis	Hospital admission rates for cases of chronic obstructive pulmonary disease of population aged 15 and over. (These admissions are considered avoidable, because it is assumed that most bronchitis cases could be handled without hospitalization.)
Avoidable hospital admission rates – Heart Failure	Hospital admission rates for cases of congestive heart failure of population aged 15 and over. (These admissions are considered avoidable, because it is assumed that most congestive heart failure cases could be handled without hospitalization.)
In-hospital case fatality rates – Acute myocardial Infarction (AMI)	The ration between the number of deaths that occurred within 30 days of hospital admission with acute myocardial infarction and the number of admissions of AMI cases
In-hospital case fatality rates – Ischemic stroke	The ration between the number of deaths that occurred within 30 days of hospital admission with ischemic stroke and the number of admissions of ischemic stroke cases

Amenable mortality indicators	**Definition**

All causes	Number of deaths by all causes
Infectious diseases	Number of deaths caused by infectious diseases
Cancers	Number of deaths caused by cancers
Endocrine, nutritional and metabolic diseases	Number of deaths caused by endocrine, nutritional and metabolic diseases
Diseases of nervous system	Number of deaths caused by diseases of nervous system
Diseases of circulatory system	Number of deaths caused by diseases of circulatory system
Diseases of genitor-urinary system	Number of deaths caused by diseases of genitor-urinary system
Diseases of respiratory system	Number of deaths caused by diseases of respiratory system
Diseases of digestive system	Number of deaths caused by diseases of digestive system
Perinatal mortality	Number of perinatal deaths per 1000 total births

Prices and physical resources	**Definition**
Total health expenditure	Total health expenditure per capita, USD PPP
Practicing physicians	Density of practicing physicians per 1000 population
Practicing nurses	Density of practicing nurses per 1000 population
Medical graduates	Density of medical graduates per 1000 population
MRI units	Number of magnetic resonance imaging units, per million population
Computed tomography scanners	Number of computed tomography scanners, per million population
Number of acute care beds	Number of acute care beds per 1000 population
Remuneration of hospital nurses	Nurses' income per capita GPD
Remuneration of general practitioners	General practitioners' income per capita GDP
Remuneration of specialists	Specialists' income per capita GDP
Relative health prices to GDP	Relative health price levels on GDP, 2008 PPP benchmark. (It indicates the level of health price relative to the general price level in the country)

Activity and consumption indicators	**Definition**
Spending to GDP	Total health expenditure per capita, percentage of GDP
Doctor consultations	Number of doctor consultations per capita
Hospital discharges	Number of hospital discharges of all causes, per 100000 population
Hip replacement	Number of hip replacement procedures, per 100000 population
Knee replacement	Number of knee replacement procedures, per 100000 population
Appendectomy	Number of appendectomy procedures, per 100000 population
Caesareans sections	Number of caesareans procedures, per 1000 live births
Antidepressants	Consumption of antidepressants, defined daily dosage per 1 000 inhabitants per day
Anxiolytics	Consumption of anxiolytics, defined daily dosage per 1 000 inhabitants per day
Analgesics	Consumption of analgesics, defined daily dosage per 1 000 inhabitants per day
Antiinflamatory, antirheumatism	Consumption of antiinflammatory and antirheumatic products non-steroids, defined daily dosage per 1 000 inhabitants per day
Antibacterials for systemic use	Consumption of antibacterials for systemic use, defined daily dosage per 1 000 inhabitants per day
Cardiovascular system	Consumption of pharmaceuticals for the cardiovascular system, defined daily dosage per 1 000 inhabitants per day
Drugs for diabetes	Consumption of drugs used in diabetes, defined daily dosage per 1 000 inhabitants per day

Financing and spending indicators	**Definition**
Public spending	Percentage of total health expenditure that is financed by the general government
General government funding	Percentage of total health expenditure that is financed by the general government, excluding social security expenditure

Social security funding	Percentage of total health expenditure that is financed by social security funds
Private health insurance funding	Percentage of total health expenditure that is financed by private health insurance
Out-of-pocket payments	Percentage of total health expenditure that is financed by private households out-of-pocket
Expenditure on medical goods	Percentage of total health expenditure that is spent on medical goods
Expenditure on out-patient care	Percentage of total health expenditure that is spent on out-patient curative and rehabilitative care (the patient that is not day case or over-the-night case), on home-care services and on ancillary services
Expenditure on in-patient	Percentage of total health expenditure that is spent on in-patient care (when patients are formally admitted and stay for at least one night) and day care (when patients are formally admitted for health care and are discharged on the same day)
Expenditure on collective services	Percentage of total health expenditure that is spent on prevention, public health services, health administration and health insurance

Source: Joumard et al. (2010); OECD Health Data 2014

Table A.2 – Fixed-effects estimator output: model without the variable of GDP

	Female birth b/se	Male birth b/se	Total birth b/se	Female65 b/se	Male65 b/se
logSpending	0.034***	0.045***	0.040***	0.090***	0.118***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
logAlcohol	-0.013	-0.027	-0.020	-0.040	-0.058
	(0.01)	(0.02)	(0.01)	(0.03)	(0.04)
logDiet	-0.004	-0.003	-0.003	-0.016	-0.014
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
logEdu	0.050***	0.038***	0.044***	0.149***	0.103***
	(0.01)	(0.01)	(0.01)	(0.03)	(0.03)
logNOx	-0.008	-0.016*	-0.011*	-0.042**	-0.063***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
constant	3.998***	3.940***	3.967***	1.980***	1.861***
	(0.07)	(0.08)	(0.06)	(0.21)	(0.23)
R-sqr	0.791	0.782	0.802	0.797	0.821
N	225	225	225	225	225

* p<0.10, ** p<0.05, *** p<0.01

Table A.3 – Fixed effects estimator model with a variable of health stock

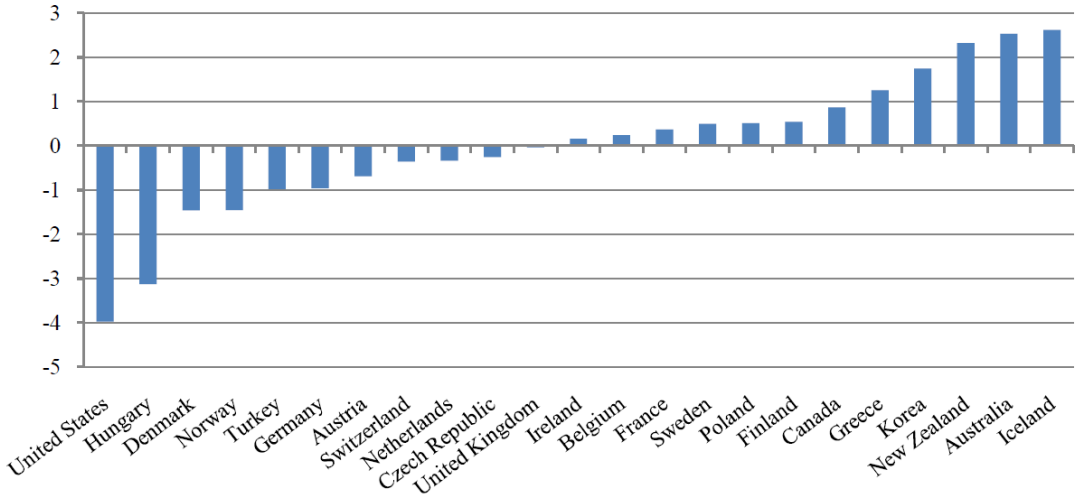
	Female birth b/se	Male birth b/se	Total birth b/se	Female65 b/se	Male65 b/se
logSpending	-0.006	-0.003	-0.004	-0.010	0.009
	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
logStock	0.032***	0.041**	0.037***	0.078***	0.086**
	(0.01)	(0.02)	(0.01)	(0.02)	(0.03)
logAlcohol	-0.009	-0.021*	-0.016	-0.031	-0.048*
	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
logDiet	-0.004	-0.003	-0.004	-0.017	-0.015
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
logEdu	0.027**	0.010	0.019	0.091*	0.040
	(0.01)	(0.02)	(0.01)	(0.05)	(0.05)
logNOx	-0.007	-0.015	-0.011	-0.042**	-0.063***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
logGDP	0.012	0.010	0.011	0.032	0.036
	(0.01)	(0.02)	(0.01)	(0.02)	(0.03)
constant	4.002***	3.963***	3.980***	1.981***	1.862***
	(0.05)	(0.11)	(0.07)	(0.27)	(0.33)
R-sqr	0.853	0.834	0.859	0.835	0.853
N	225	225	225	225	225

* p<0.10, ** p<0.05, *** p<0.01

Table A.4 – Correlations of health inputs

	spending	stock	alcohol	diet	educat~n	nox	gdp
spending	1.0000						
stock	0.9939	1.0000					
alcohol	0.0973	0.0785	1.0000				
diet	-0.0614	-0.0498	-0.4569	1.0000			
education	0.2229	0.2137	0.2397	-0.5935	1.0000		
nox	0.2505	0.2598	-0.1014	0.0356	-0.0236	1.0000	
gdp	0.7710	0.7789	0.1321	0.0093	0.1793	0.2620	1.0000

Figure A.1 – Years of life not explained by the model of fixed-effects estimator (2003)



Source: Joumard, I. *et al.* (2008)

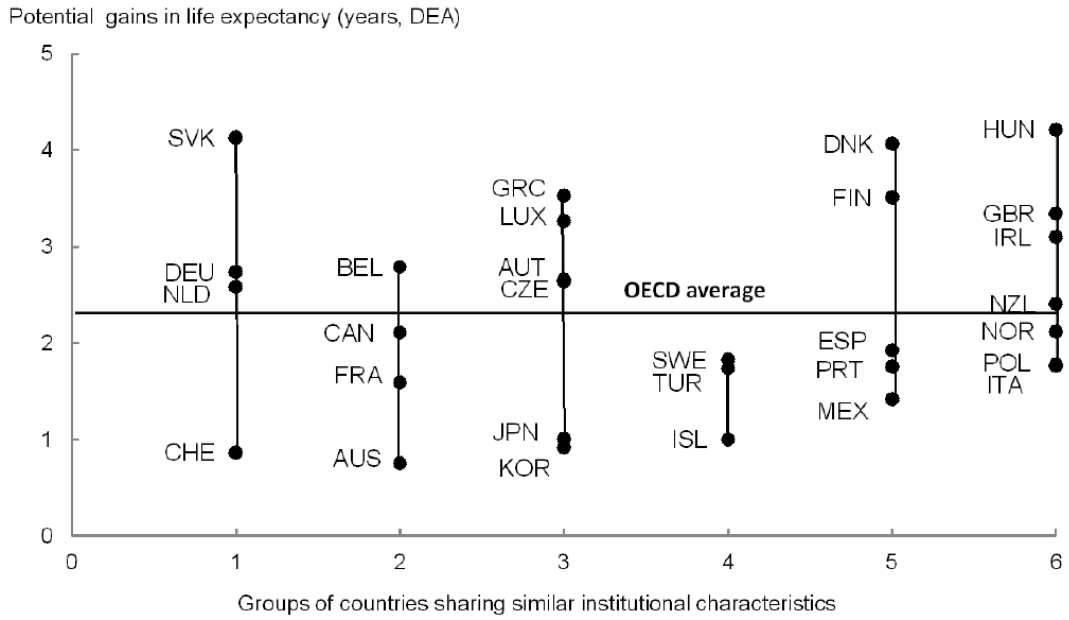
Table A.5 - Stochastic Frontier Analysis output with fixed-effects incorporated[1]

	SFA b/se
logLEtotal	
logSpending	0.022***
	(0.01)
logAlcohol	-0.017***
	(0.00)
logDiet	-0.028***
	(0.00)
logEdu	-0.018***
	(0.00)
logNOx	-0.008***
	(0.00)
logGDP	0.010
	(0.01)
constant	4.407***
	(0.10)
lnsig2v	
constant	-11.473***
	(0.25)
lnsig2u	
group(country)=1	0.000
	(.)
group(country)=2	31.057
	(1083.59)
group(country)=3	32.491
	(1083.59)
group(country)=4	29.086
	(1083.59)
group(country)=5	33.473
	(1083.59)
group(country)=6	33.351
	(1083.59)
group(country)=7	34.270
	(1083.59)
group(country)=8	32.193
	(1083.59)
group(country)=9	29.409
	(1083.59)
group(country)=10	32.539
	(1083.59)
group(country)=11	-8.993
	(12955.87)
group(country)=12	34.682
	(1083.59)
group(country)=13	26.539
	(1083.59)
group(country)=14	32.121
	(1083.59)
group(country)=15	29.317
	(1083.59)
group(country)=16	24.283
	(1083.62)
group(country)=17	-10.207
	(14039.05)
group(country)=18	-8.065
	(14261.86)
group(country)=19	32.093
	(1083.59)
group(country)=20	34.892
	(1083.59)
group(country)=21	32.476
	(1083.59)
group(country)=22	27.854
	(1083.59)
group(country)=23	32.460
	(1083.59)
group(country)=24	33.731
	(1083.59)
group(country)=25	32.412
	(1083.59)
group(country)=26	34.537
	(1083.59)
group(country)=27	32.045
	(1083.59)
group(country)=28	-9.790
	(13402.94)
group(country)=29	31.137
	(1083.59)
group(country)=30	30.965
	(1083.59)
group(country)=31	35.138
	(1083.59)
group(country)=32	31.722
	(1083.59)
group(country)=33	34.070
	(1083.59)
constant	-39.784
	(1083.59)
N	225.000

* p<0.10, ** p<0.05, *** p<0.01

[1] country 1 = Australia; country 2 = Austria; country 3 = Belgium ; country 4 = Canada; country 5 = Czech Republic; country 6 = Denmark; country 7 = Estonia; country 8 = Finland; country 9 = France; country 10 = Germany; country 11 = Greece; country 12 = Hungary; country 13 = Iceland; country 14 = Ireland; country 15 = Israel; country 16 = Italy ; country 17 = Japan; country 18 = Korea; country 19 = Luxembourg; country 20 = Mexico; country 21 = Netherlands; country 22 = New Zealand; country 23 = Norway; country 24 = Poland; country 25 = Portugal; country 26 = Slovak Republic; country 27 = Slovenia; country 28 = Spain; country 29 = Sweden; country 30 = Switzerland; country 31 = Turkey; country 32 = United Kingdom; country 33 = United States of America

Figure A.2 - Potential gains in life expectancy at birth across and within country groups plot (DEA), 2007

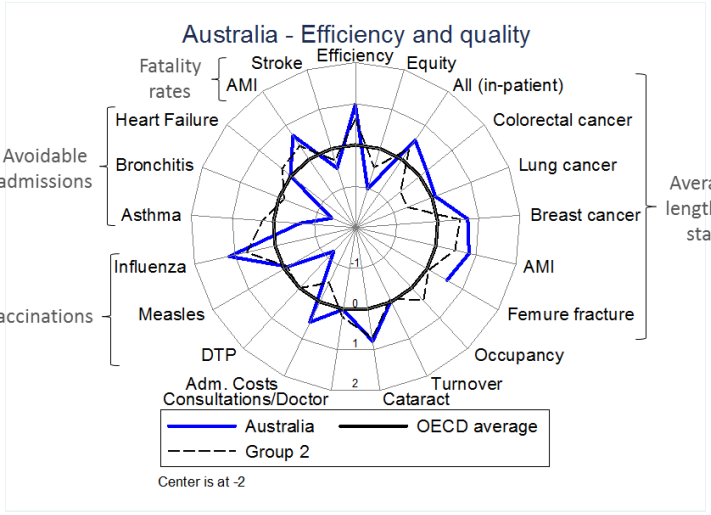


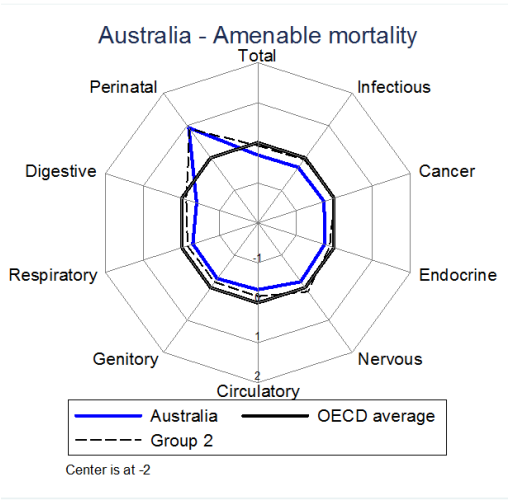
Source: Joumard, I., C. André and C. Nicq (2010)

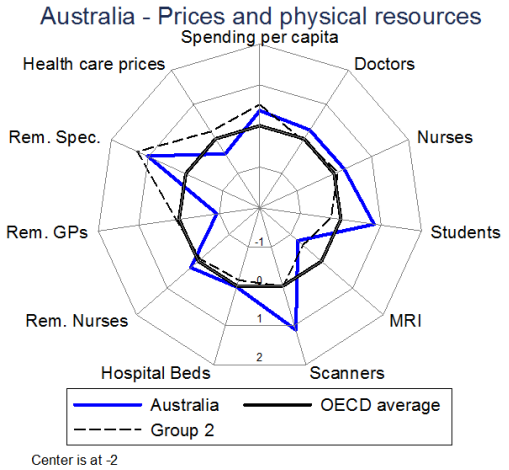
Table A.6 – Descriptive statistics of inputs and outputs

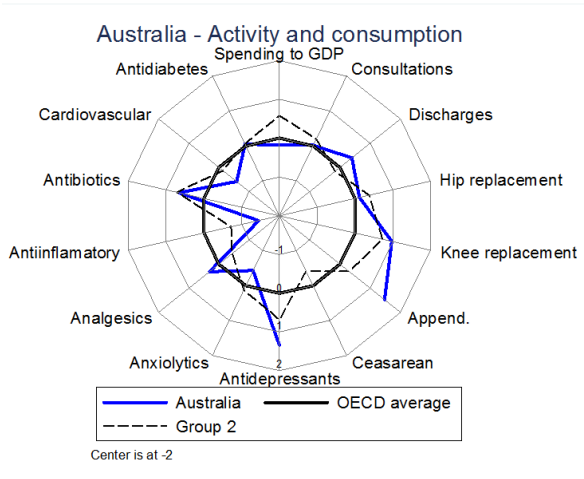
Variable	Obs	Mean	Std. Dev.	Min	Max
spending	231	3100.376	1444.802	590.6946	8482.719
stock	231	6886.944	3306.759	1151.895	19587.48
alcohol	231	9.516883	2.809614	1.2	14.8
diet	231	224.3026	59.76859	132.9	433.8
education	231	73.31004	17.0898	26.44	100
nox	225	29.07467	16.96752	9.6	86.7
gdp	231	33654.81	12891.13	10840.8	88848.1
le_totalbi~h	231	79.32641	2.589468	72.9	83
le_fembirth	231	82.15541	2.271555	75.2	86.4
le_malbirth	231	76.45238	3.076557	67.5	80.7
le_fem65	231	20.47056	1.588409	15.6	24
le_mal65	231	17.03636	1.54345	13.1	19.3

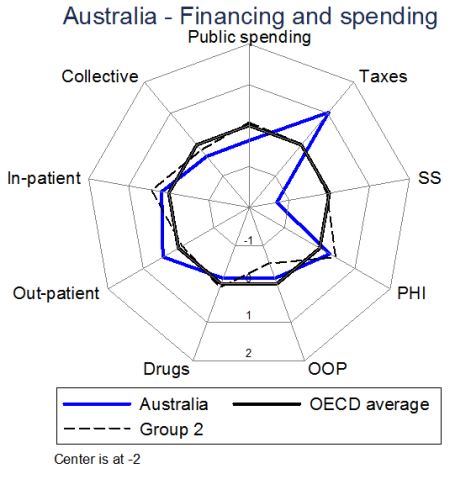
Figure A.3 - Health indicators: Australia, 2011 (or latest year available)[2]





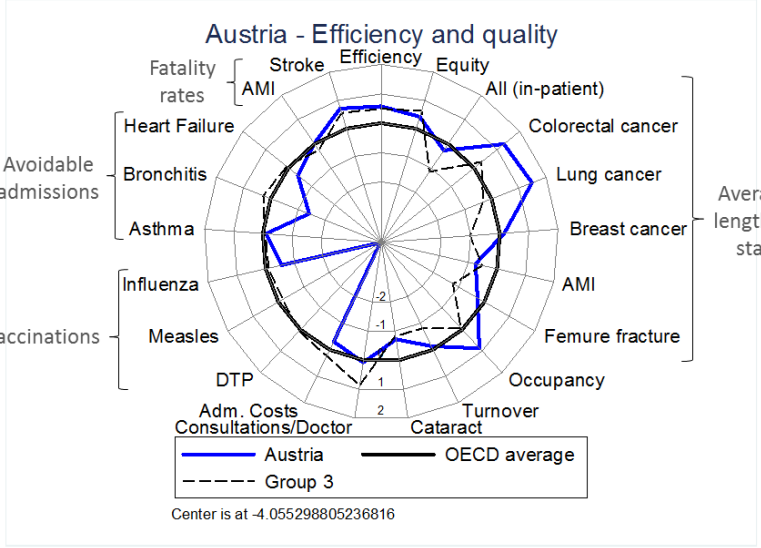


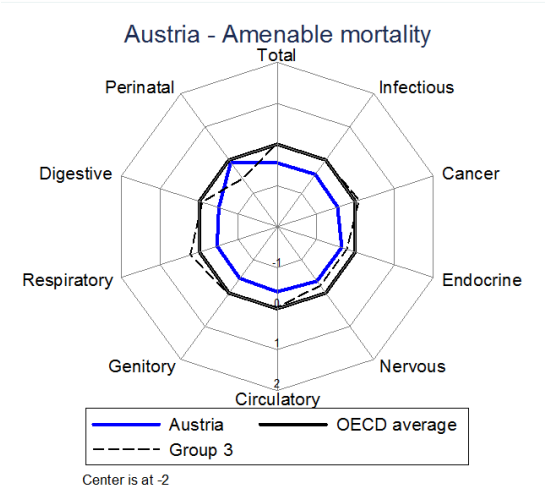


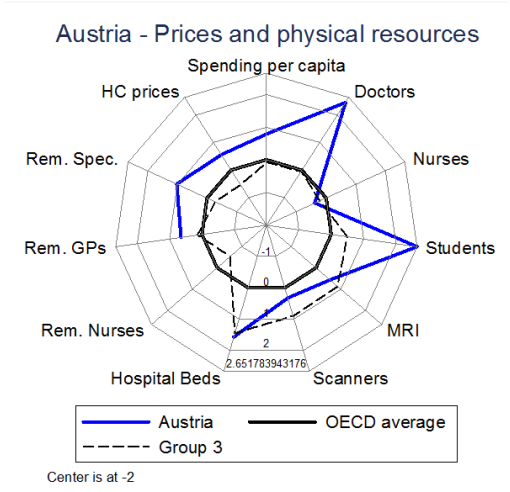


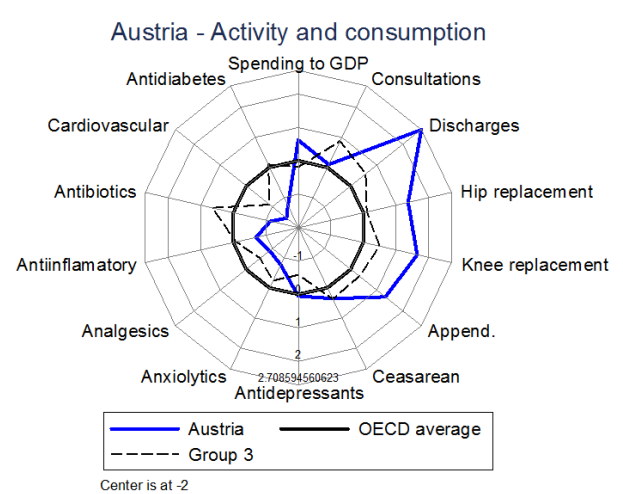
[2] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

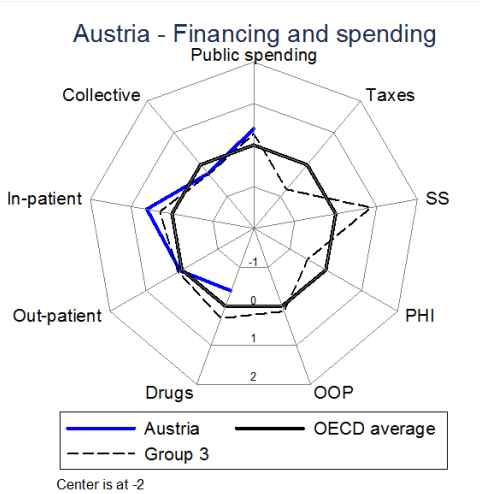
Figure A.4 - Health indicators: Austria, 2011 (or latest year available)[3]





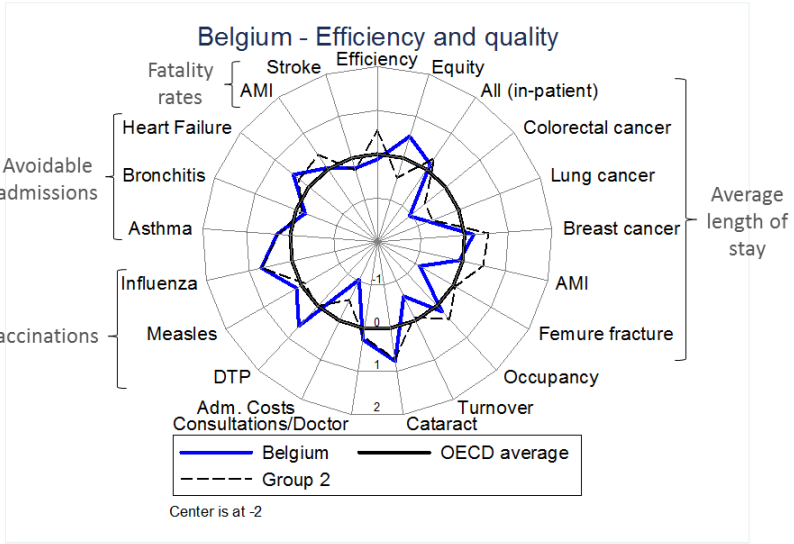


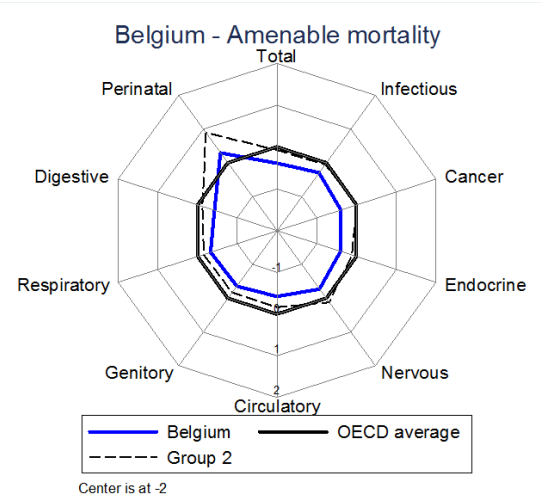


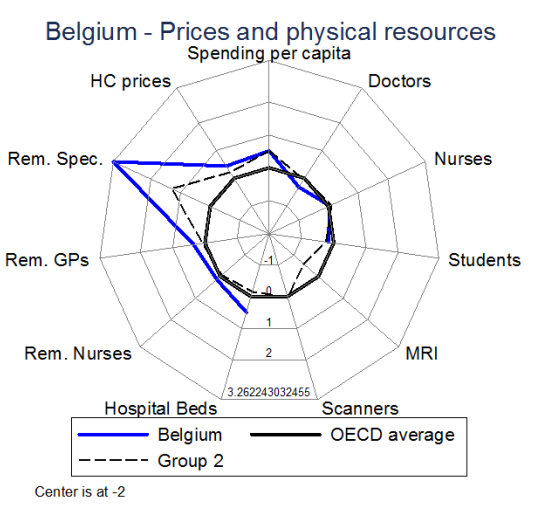


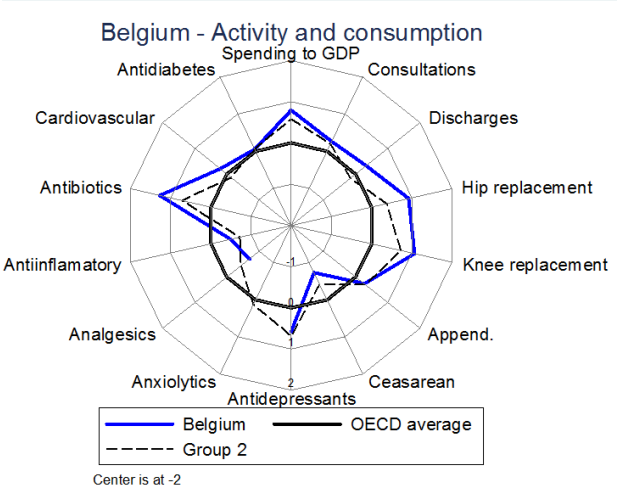
[3] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

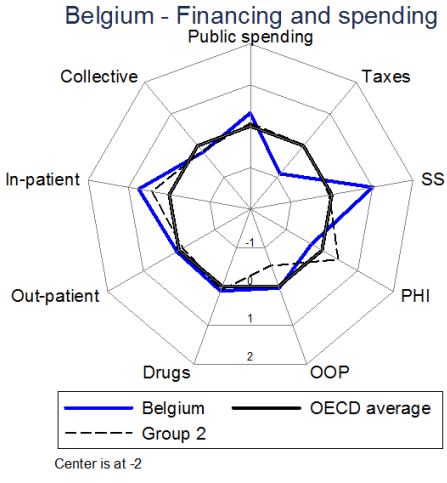
Figure A.5 - Health indicators: Belgium, 2011 (or latest year available)[4]





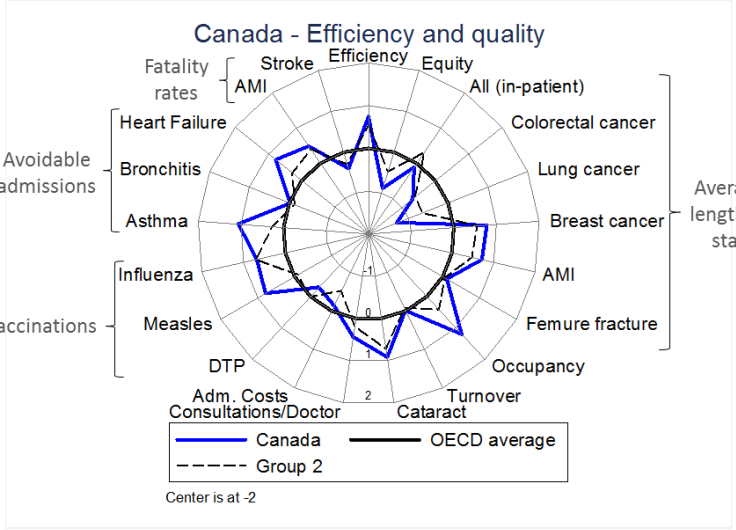


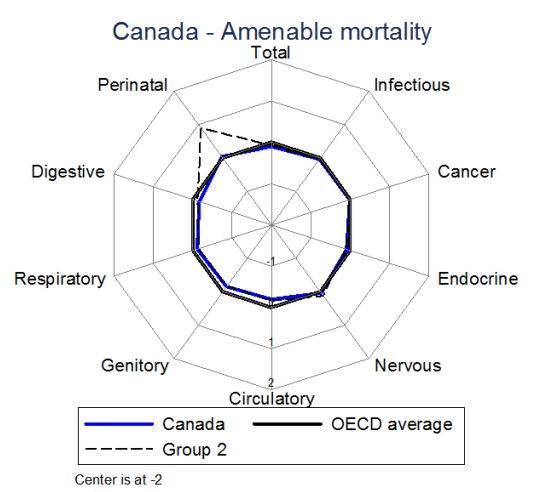


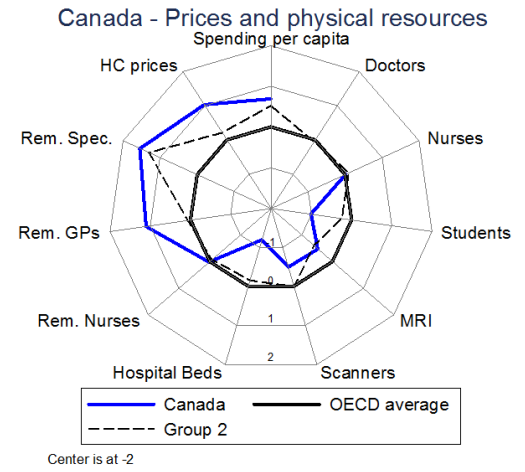


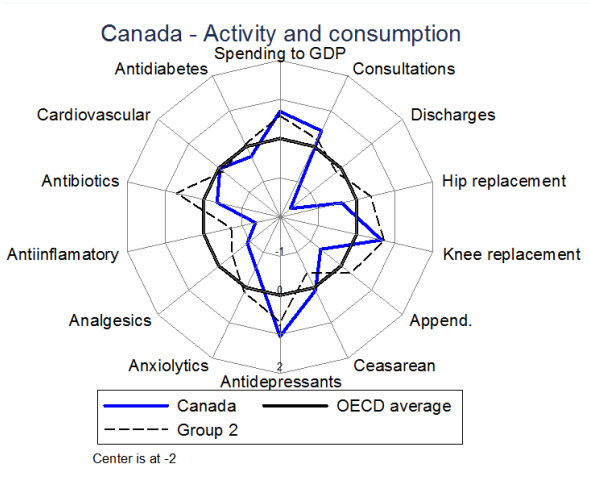
[4] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

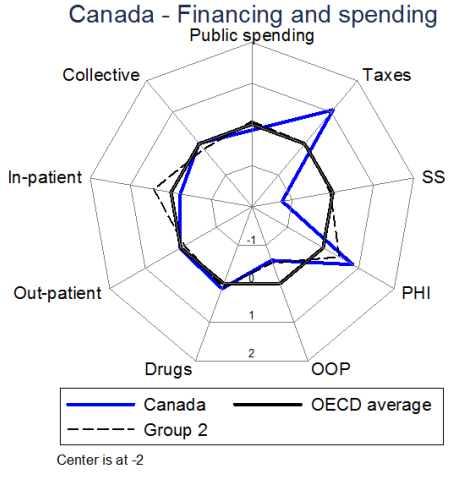
Figure A.6 - Health indicators: Canada, 2011 (or latest year available)[5]





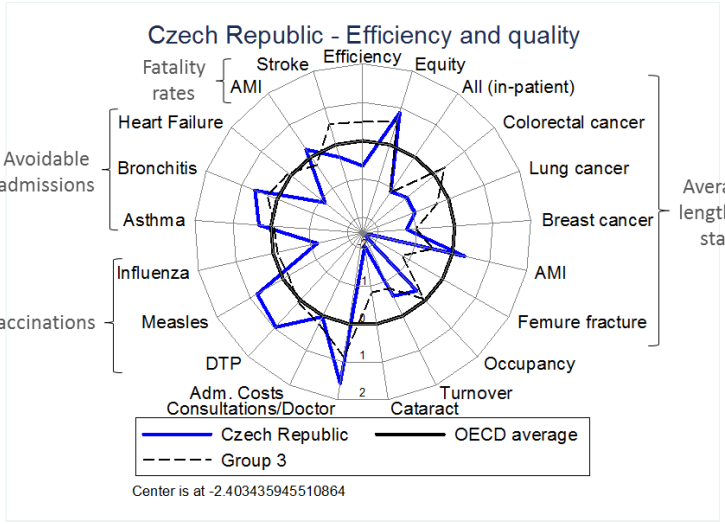


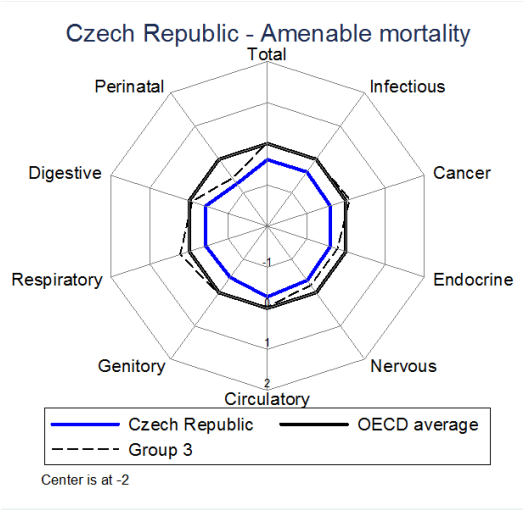


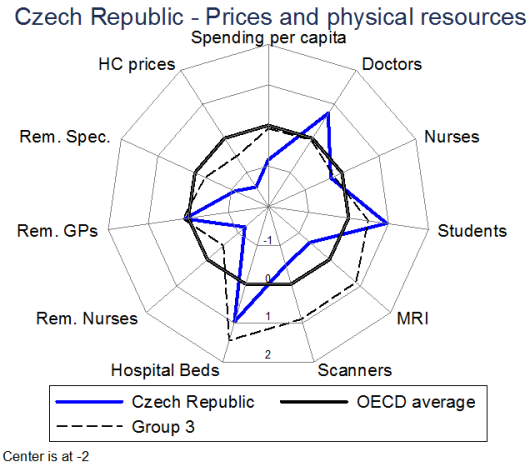


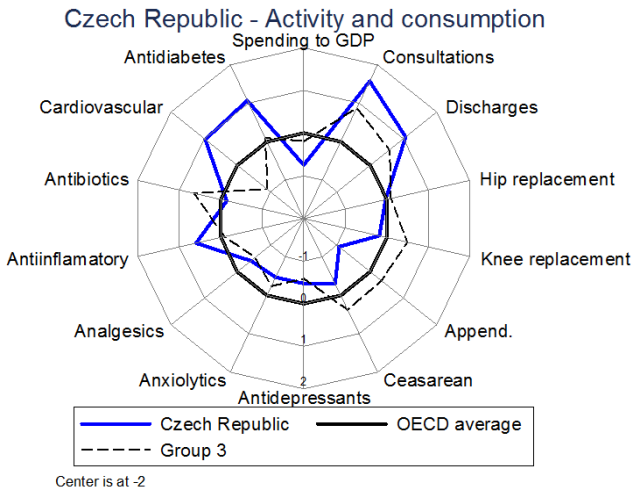
[5] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

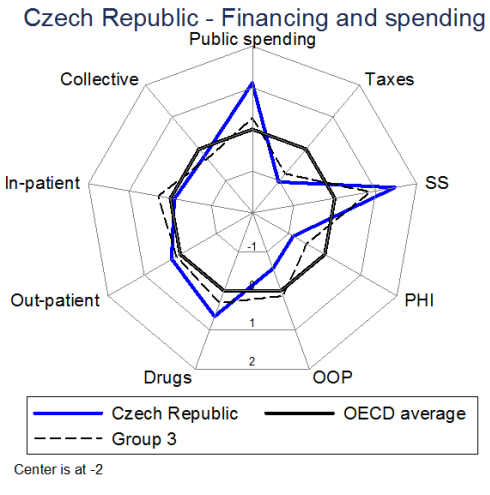
Figure A.7 - Health indicators: Czech Republic, 2011 (or latest year available)[6]





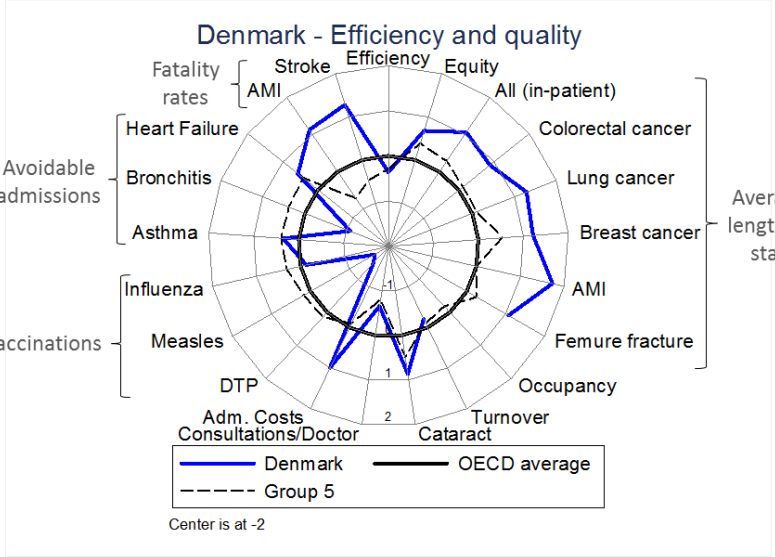


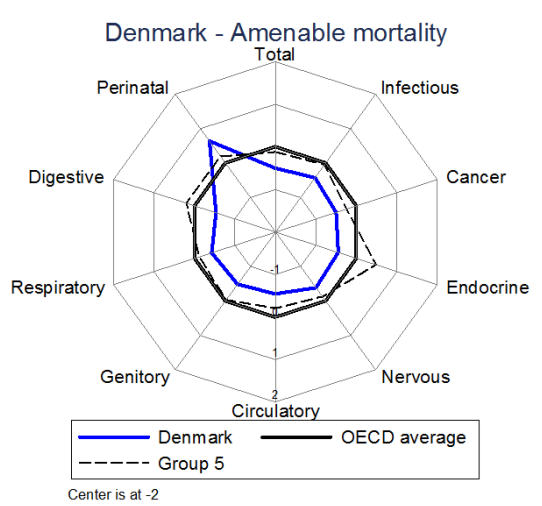


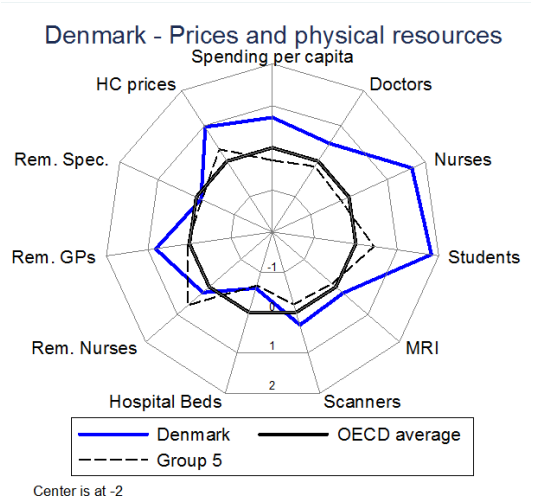


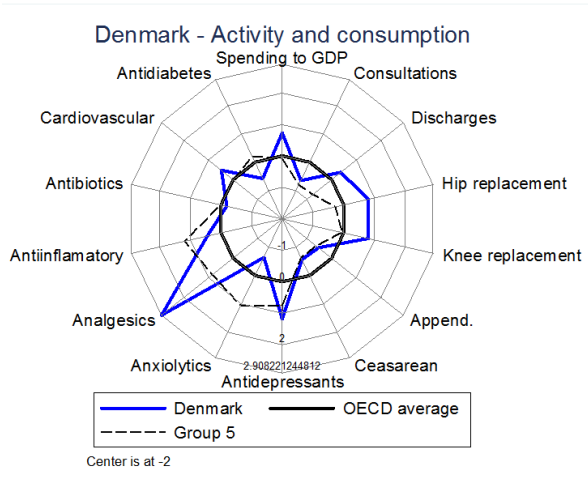
[6] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

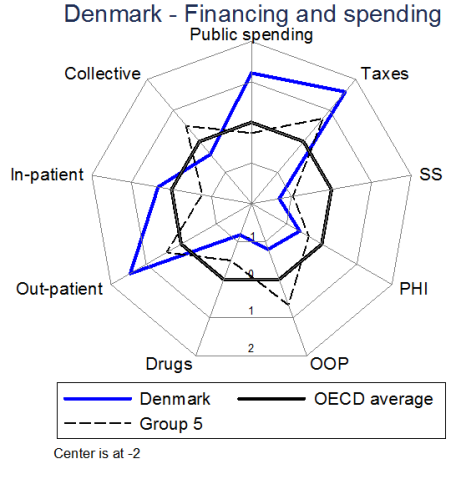
Figure A.8 - Health indicators: Denmark, 2011 (or latest year available)[7]





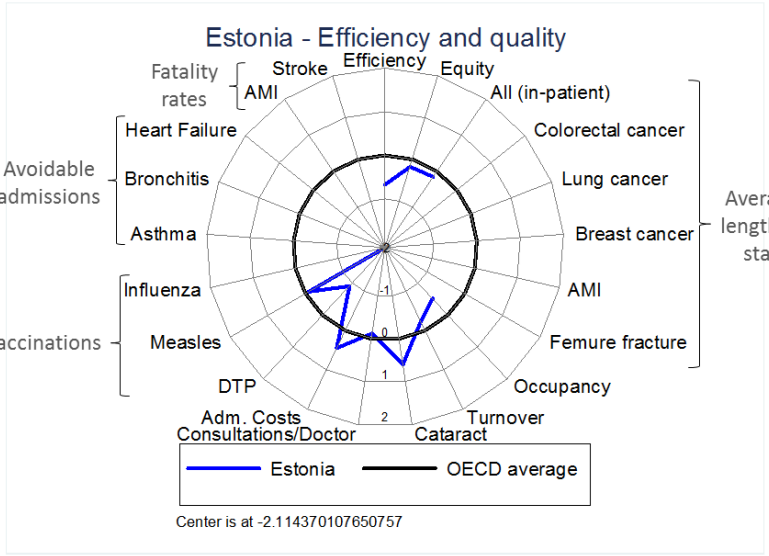


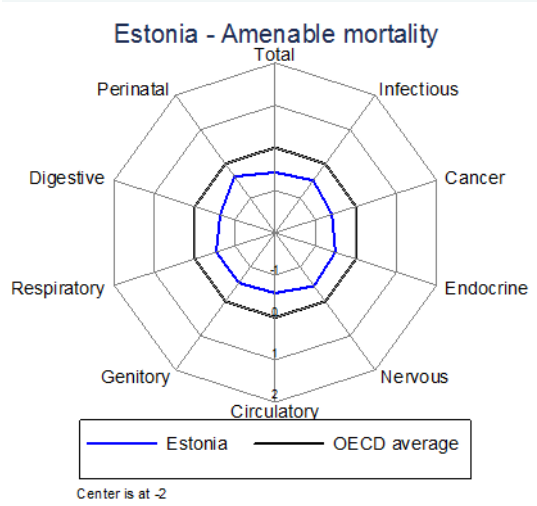


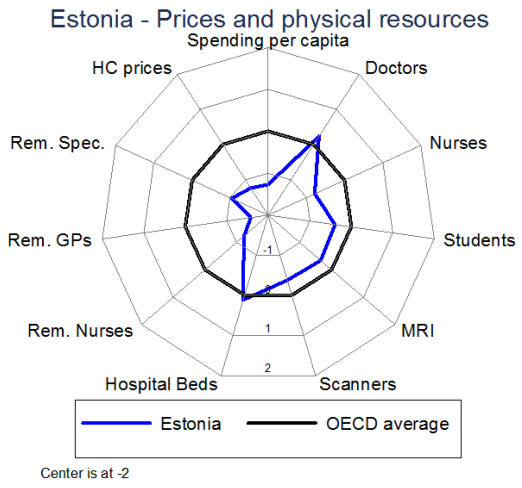


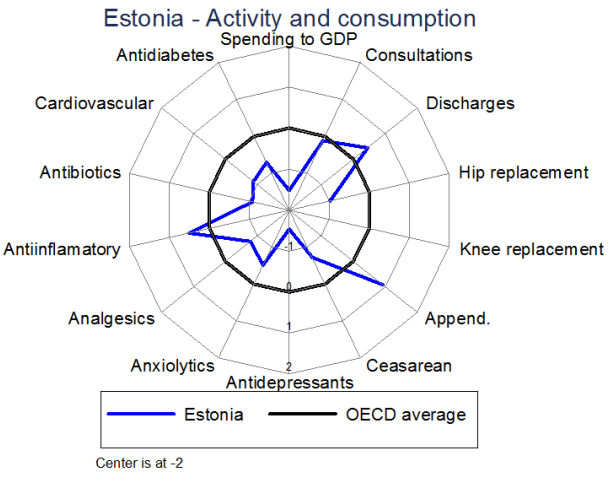
[7] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

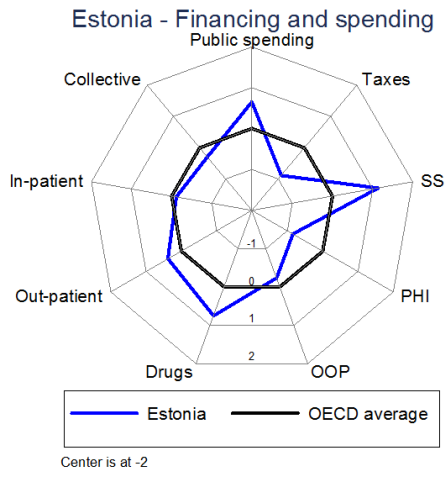
Figure A.9 - Health indicators: Estonia, 2011 (or latest year available)[8]





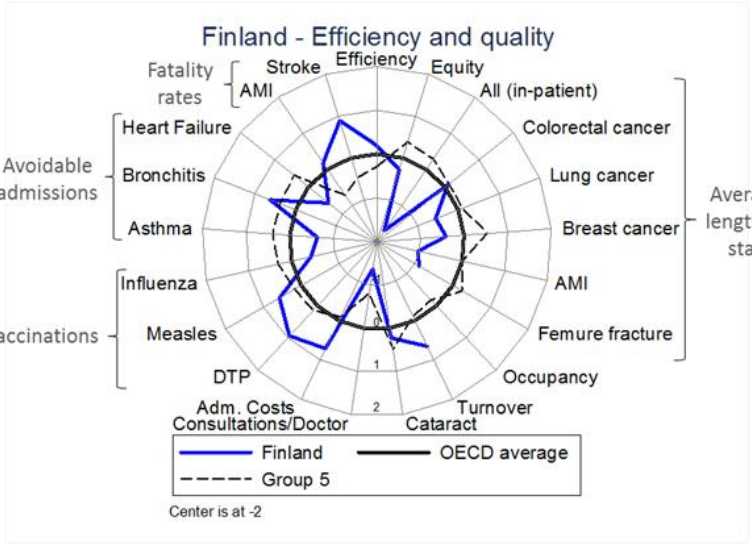


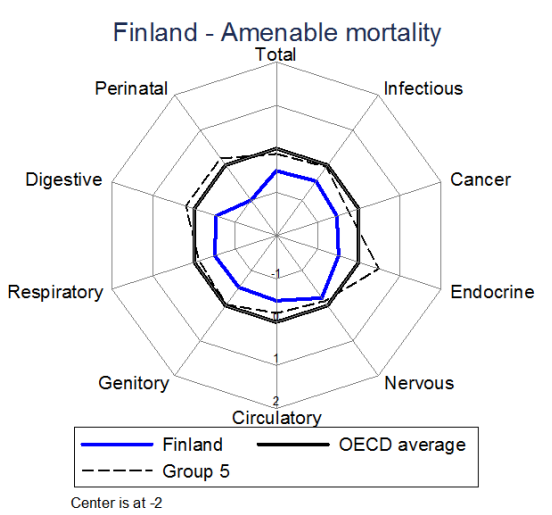


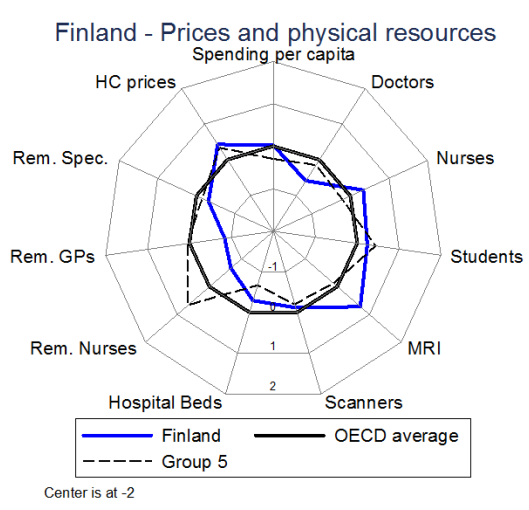


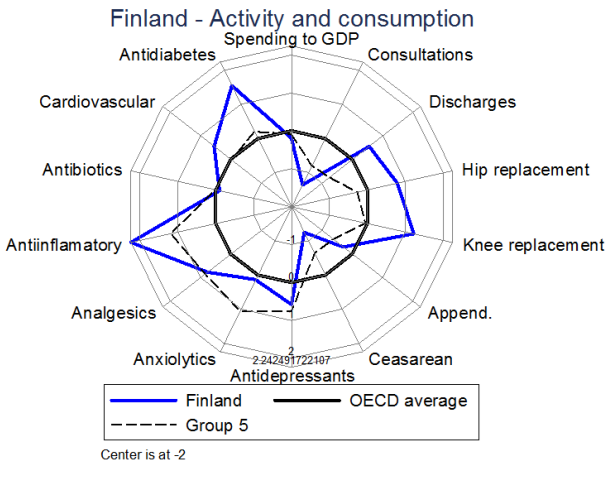
[8] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

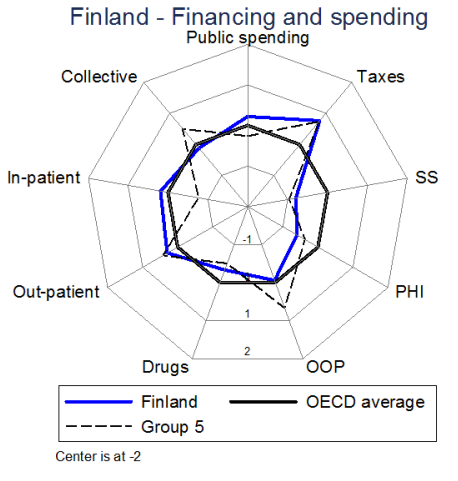
Figure A.10 - Health indicators: Finland, 2011 (or latest year available)[9]





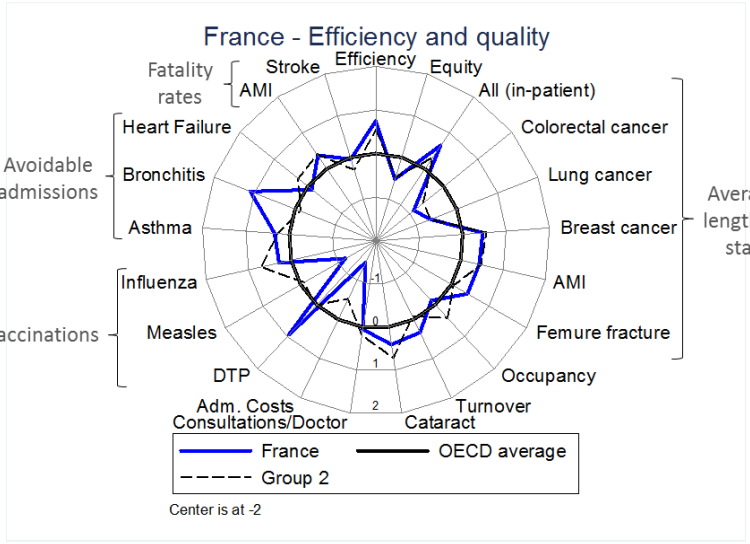


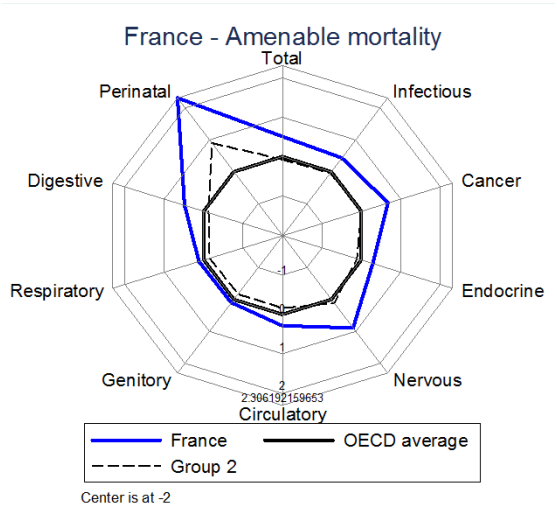


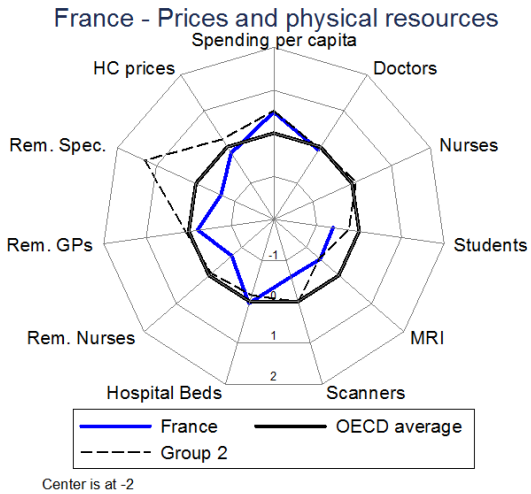


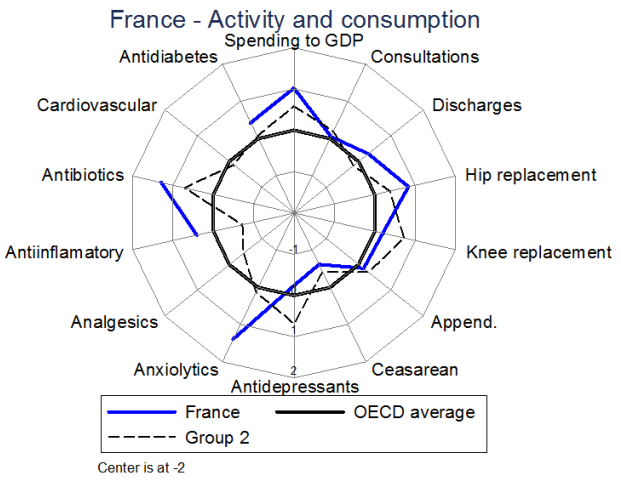
[9] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

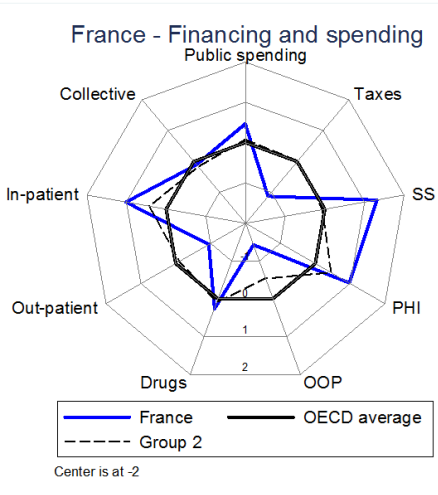
Figure A.11 - Health indicators: France, 2011 (or latest year available)[10]





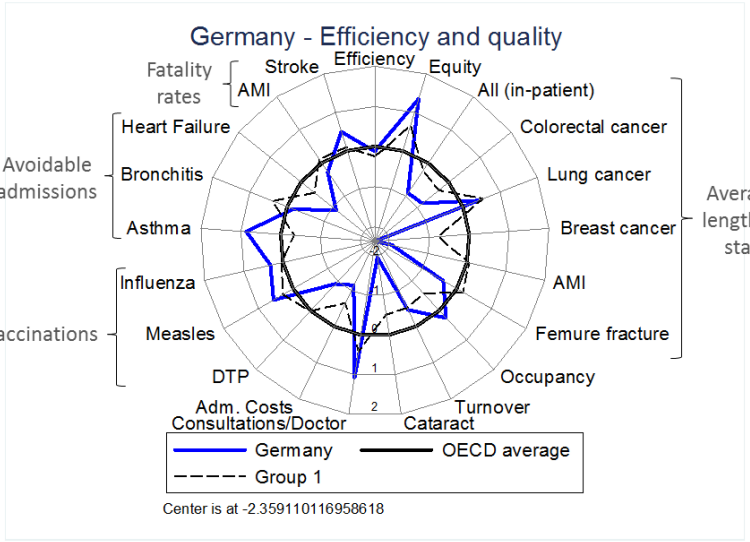


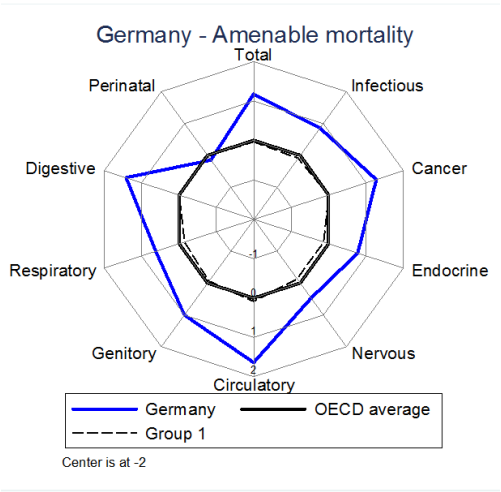


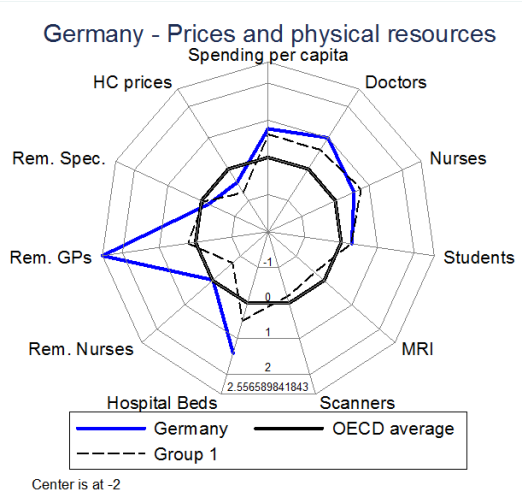


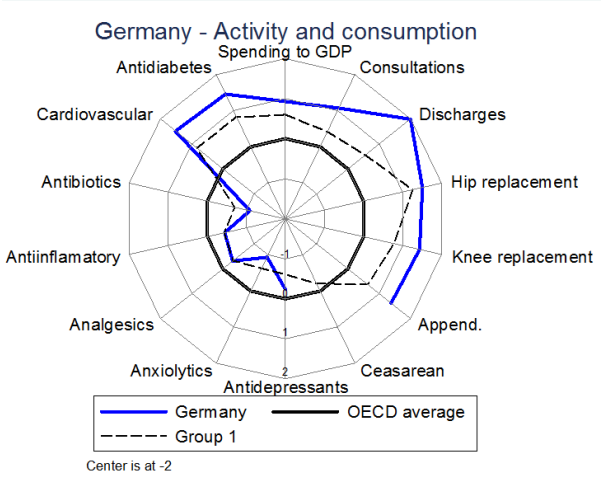
[10] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

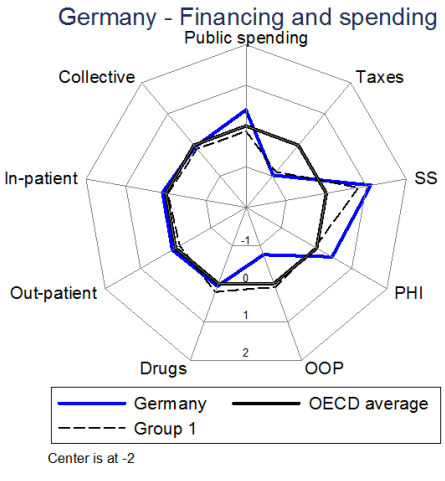
Figure A.12 - Health indicators: Germany, 2011 (or latest year available)[11]





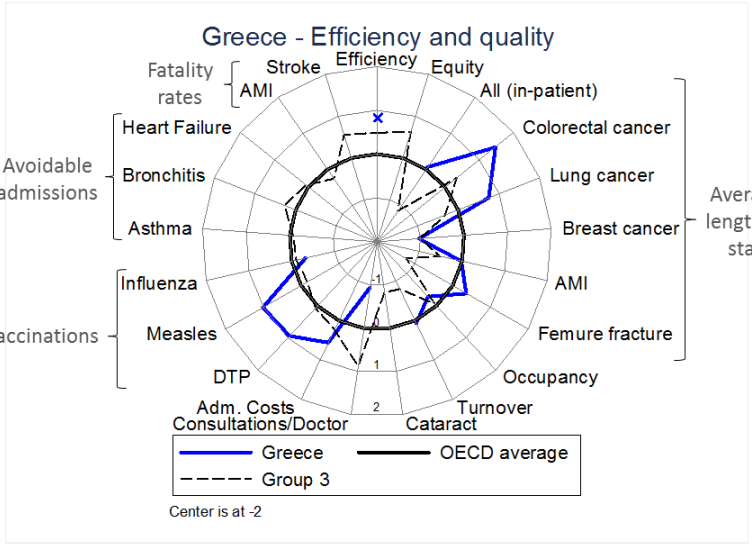


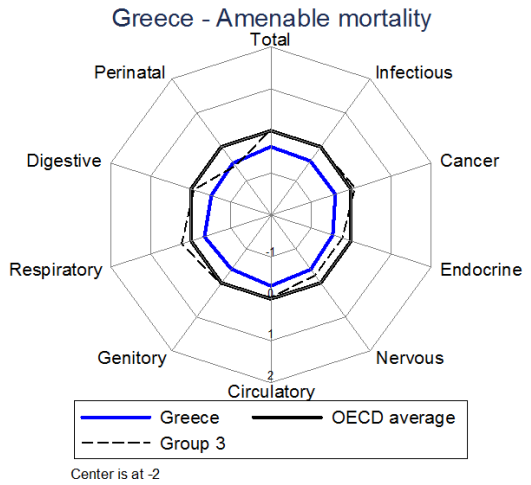


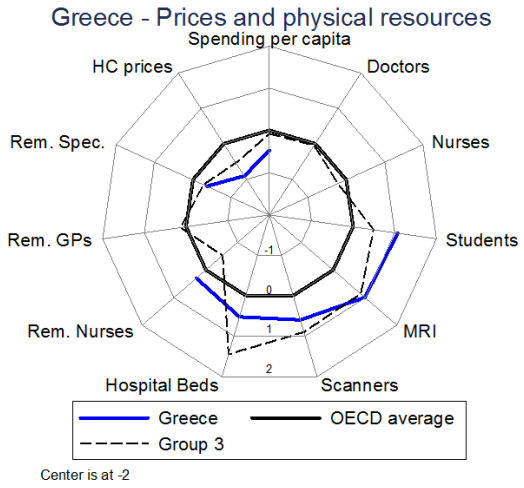


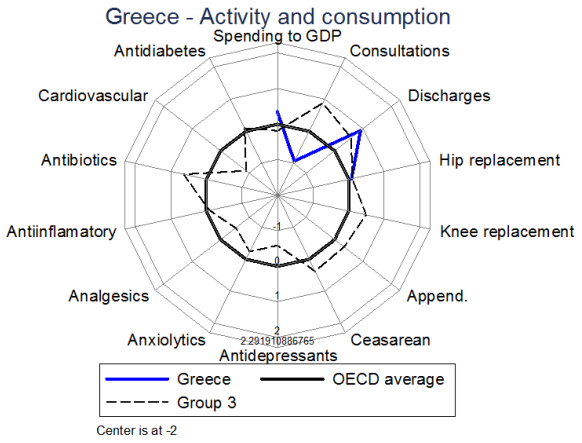
[11] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

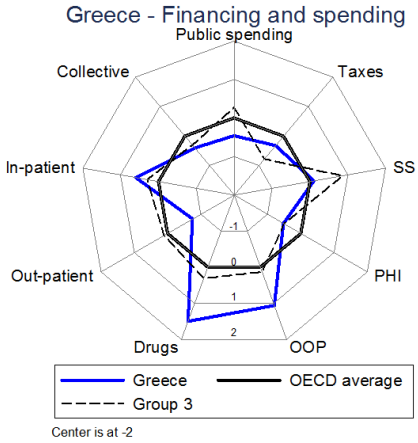
Figure A.13 - Health indicators: Greece, 2011 (or latest year available)[12]





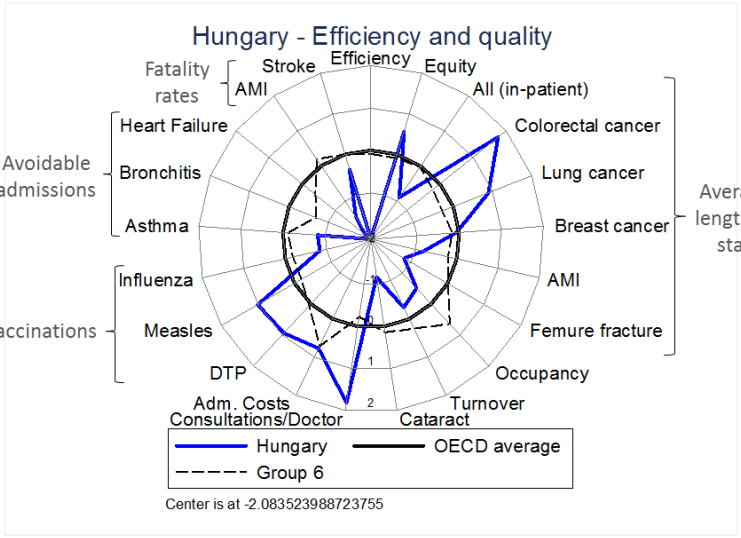


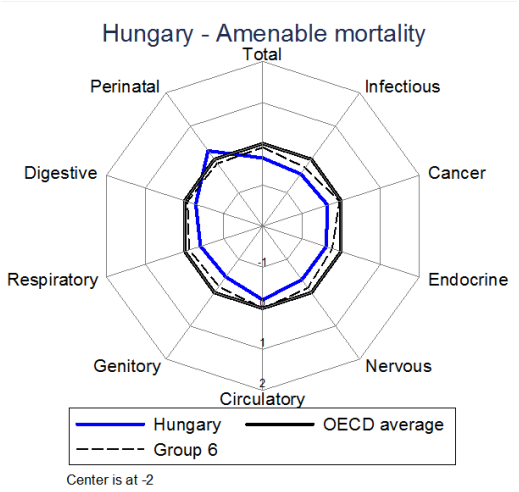


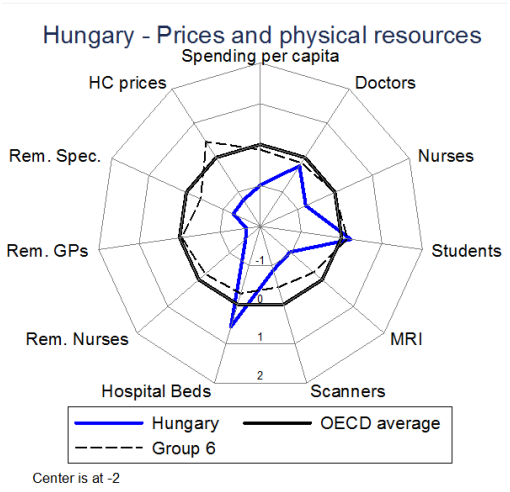


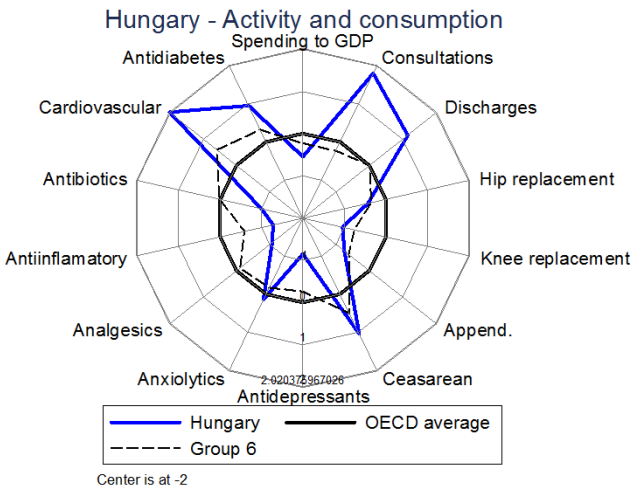
[12] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

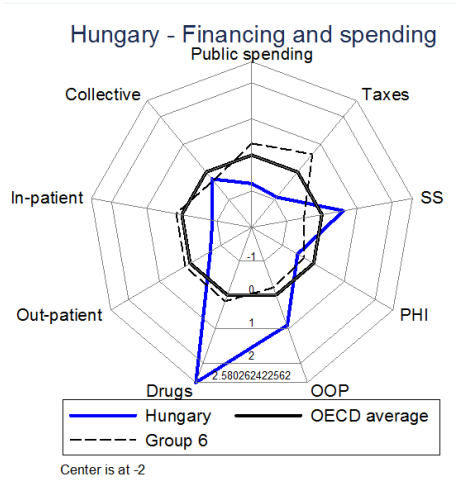
Figure A.14 - Health indicators: Hungary, 2011 (or latest year available)[13]





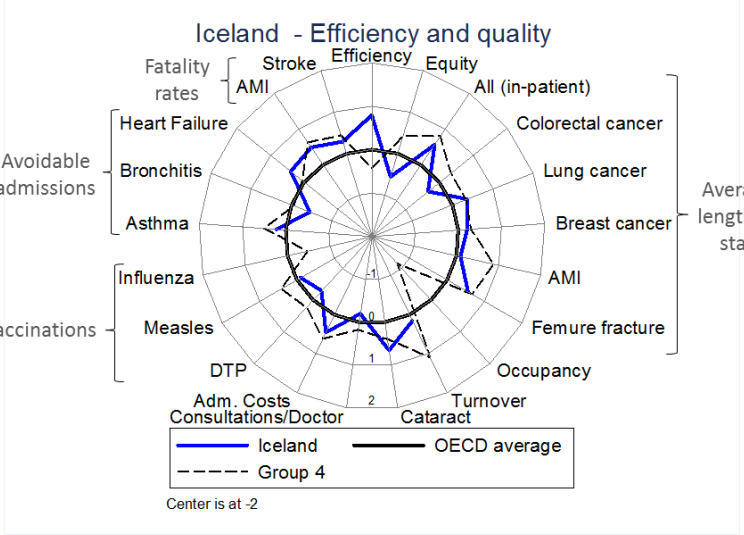


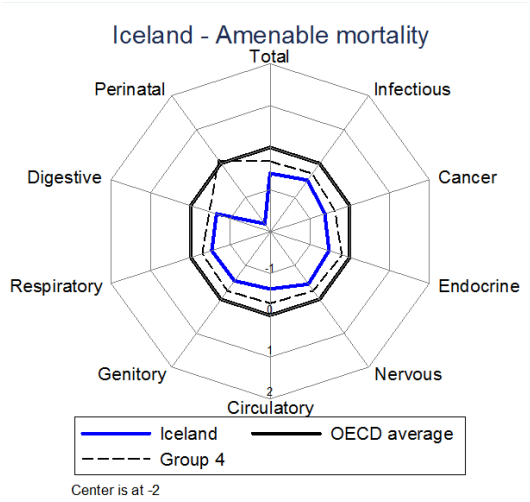


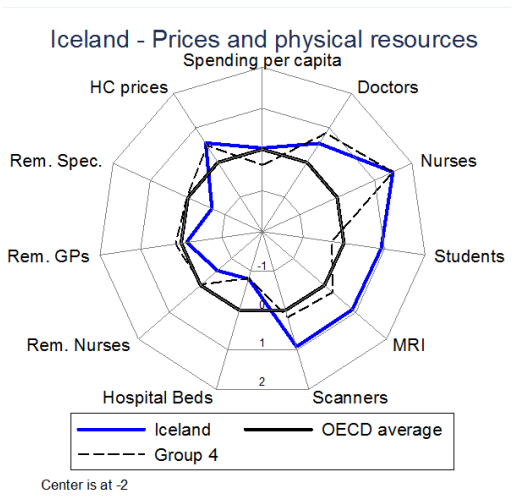


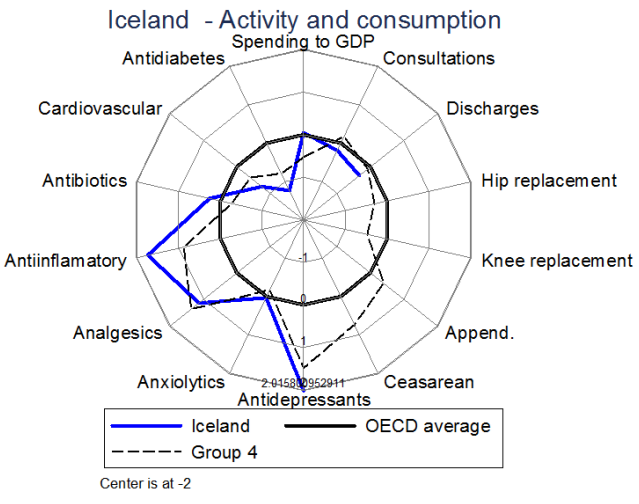
[13] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

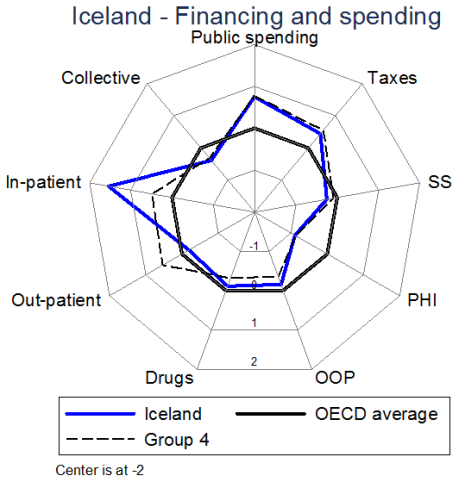
Figure A.15 - Health indicators: Iceland, 2011 (or latest year available)[14]





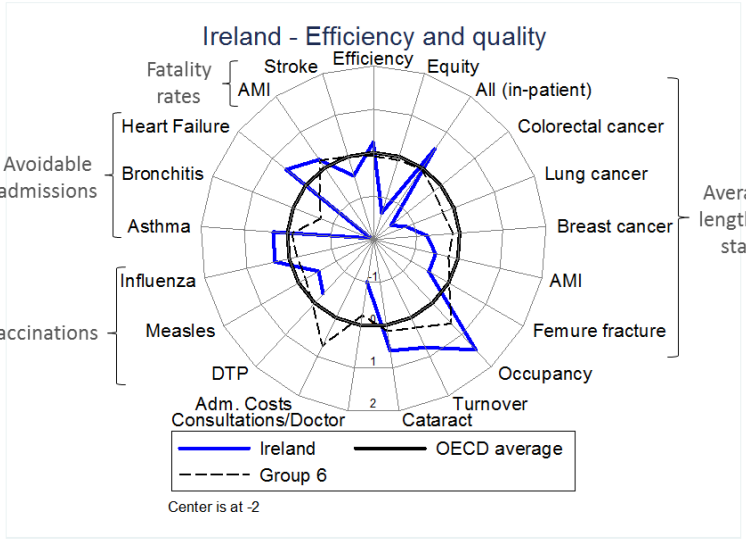


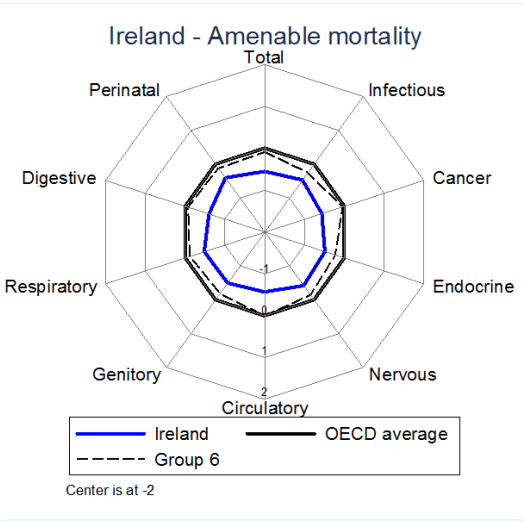


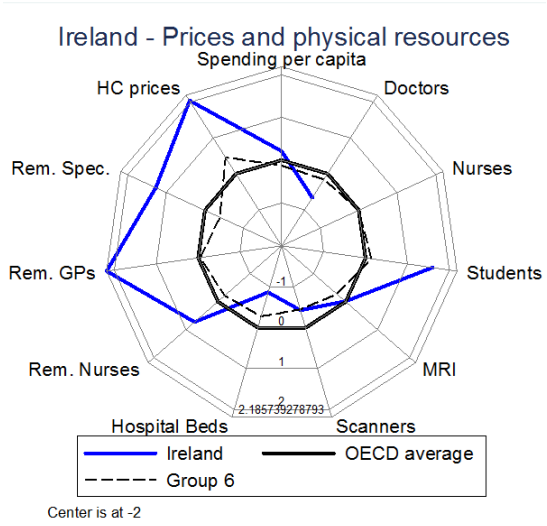


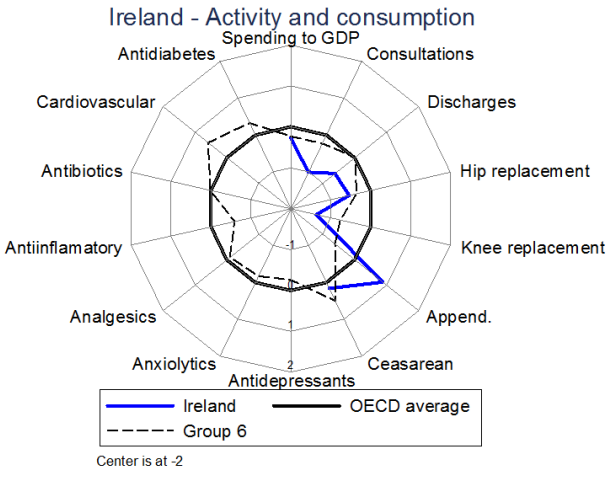
[14] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

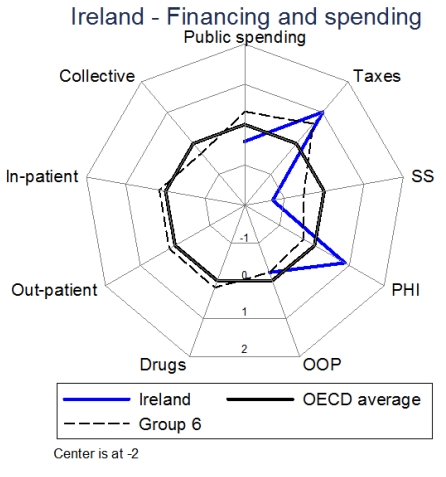
Figure A.16 - Health indicators: Ireland, 2011 (or latest year available)[15]





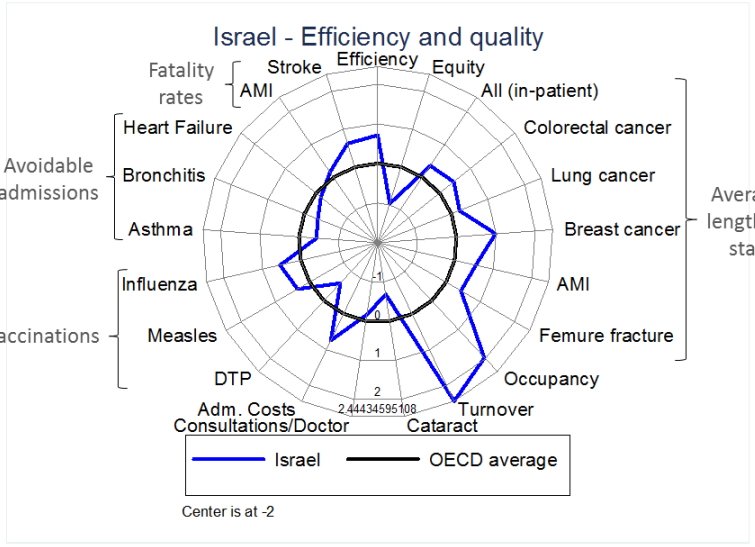


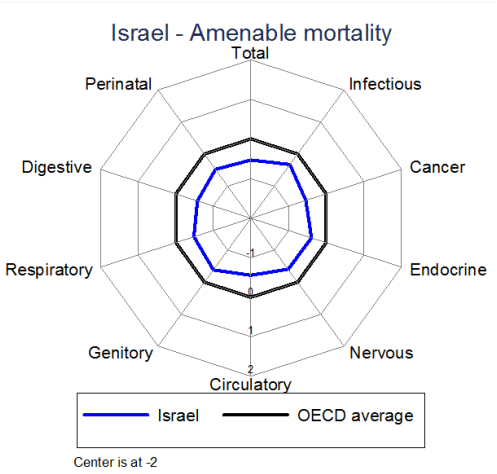


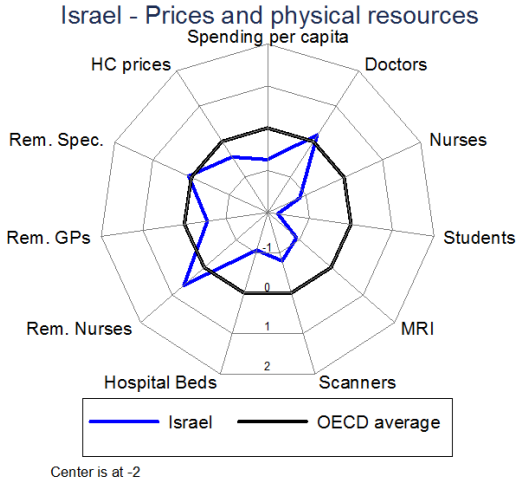


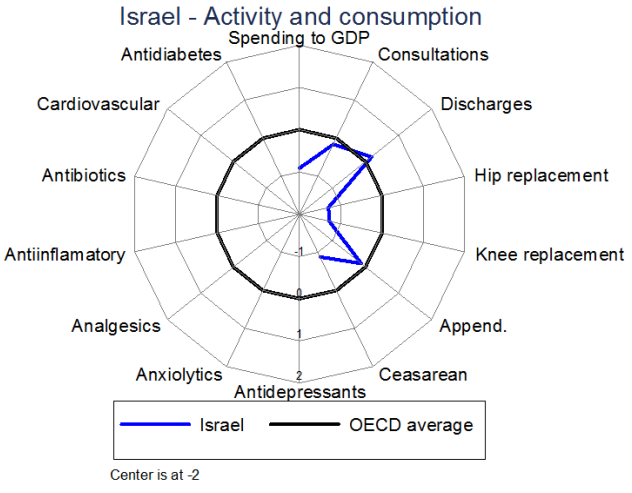
[15] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

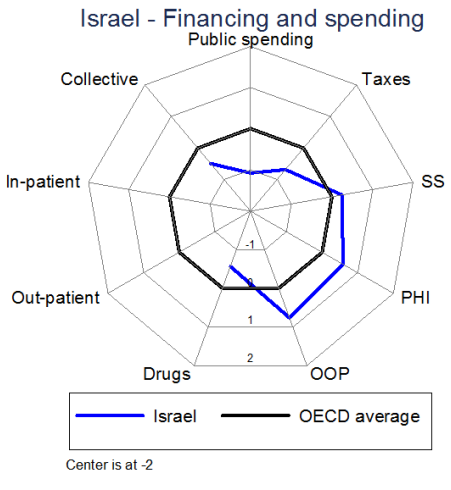
Figure A.17 - Health indicators: Israel, 2011 (or latest year available)[16]





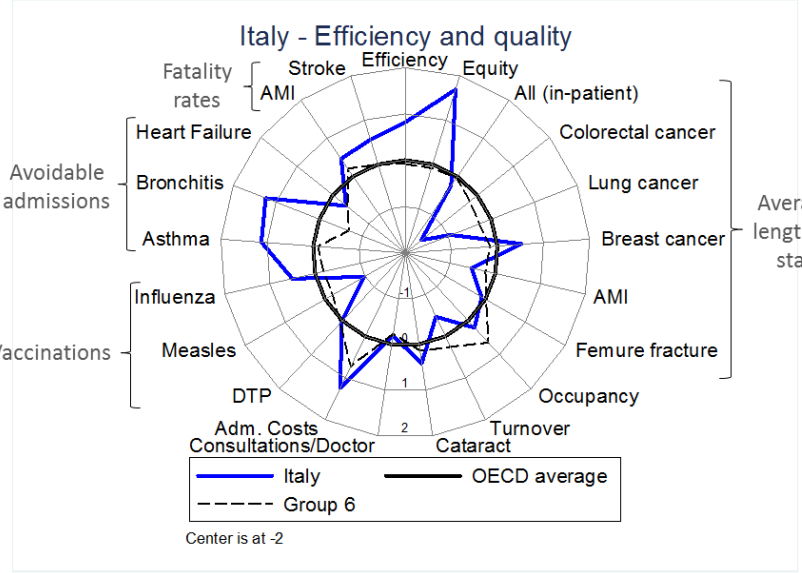


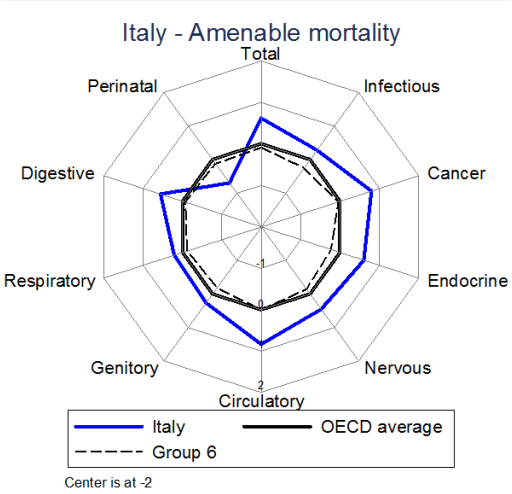


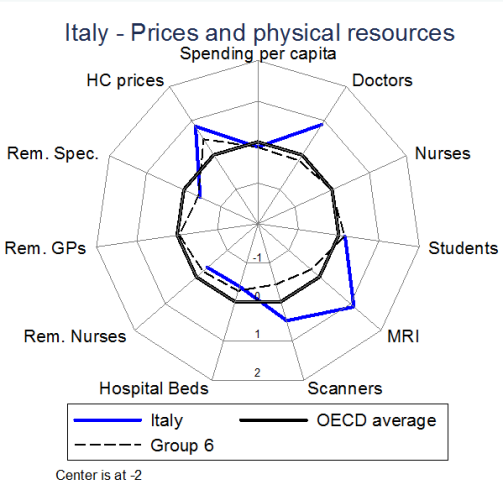


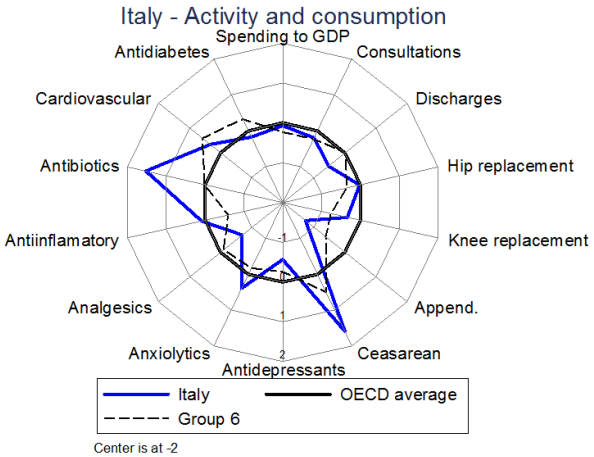
[16] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

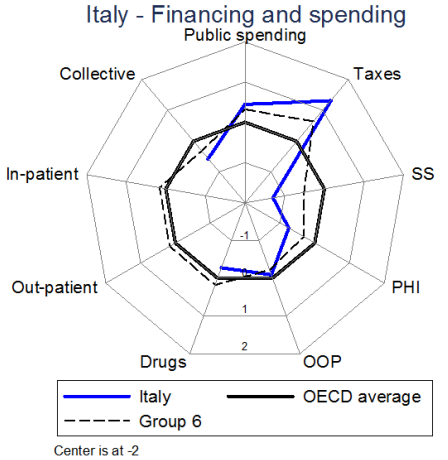
Figure A.18 - Health indicators: Italy, 2011 (or latest year available)[17]





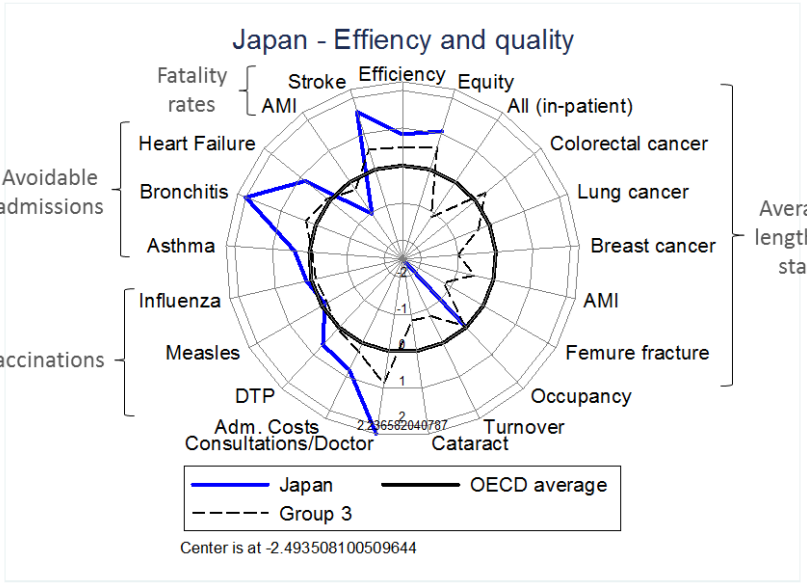


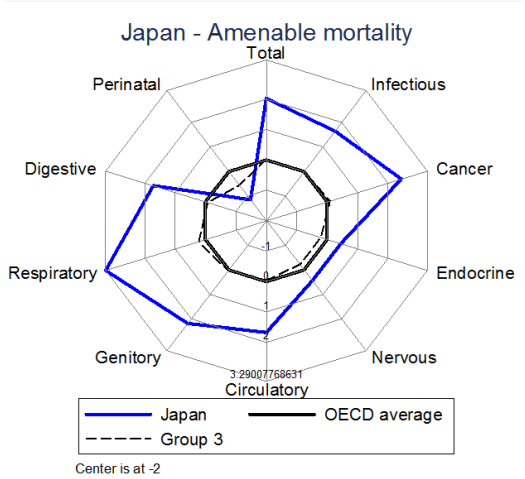


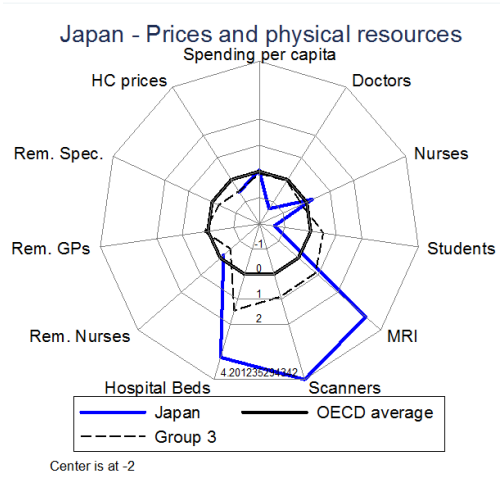


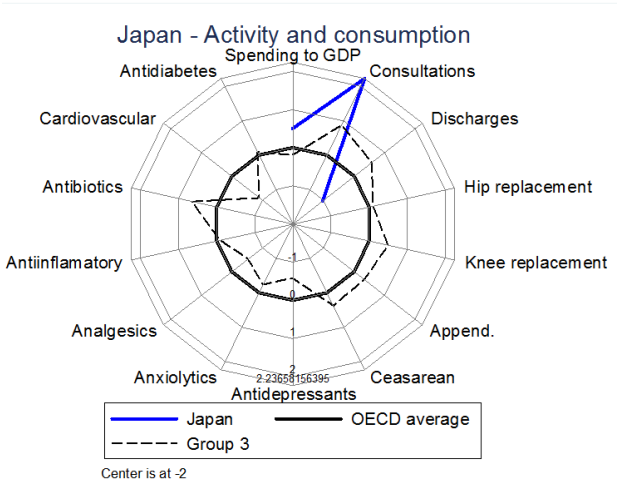
[17] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

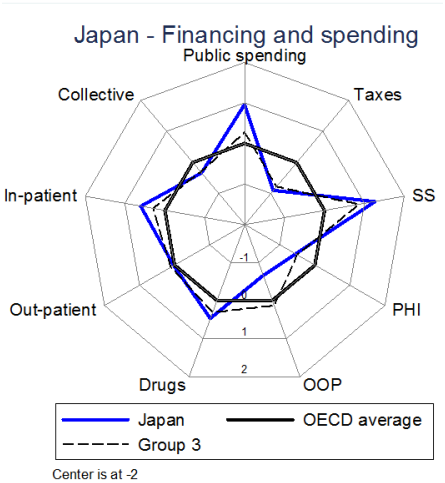
Figure A.19 - Health indicators: Japan, 2011 (or latest year available)[18]





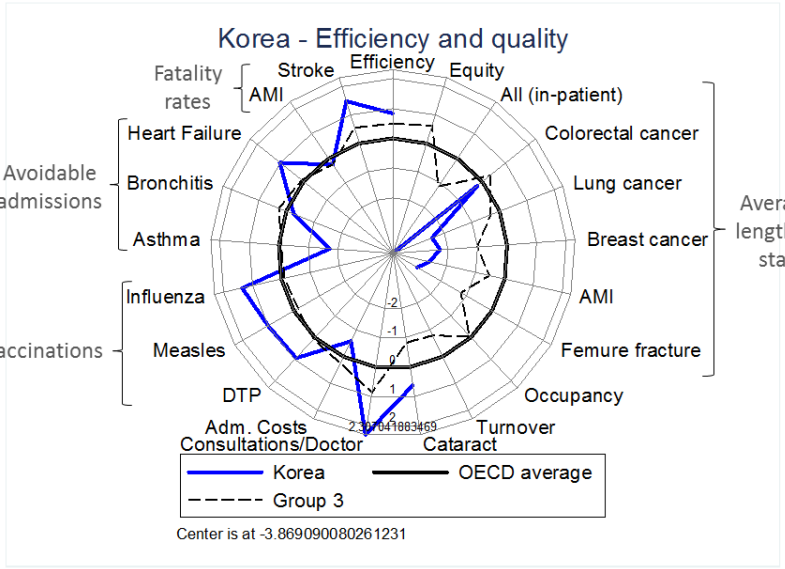


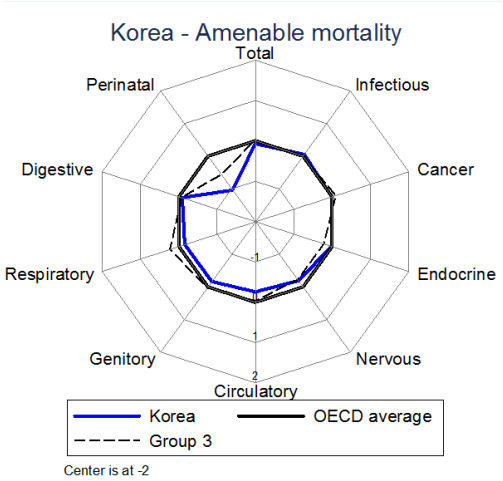


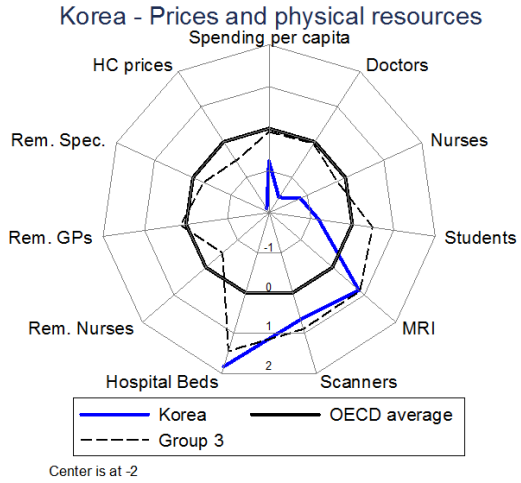


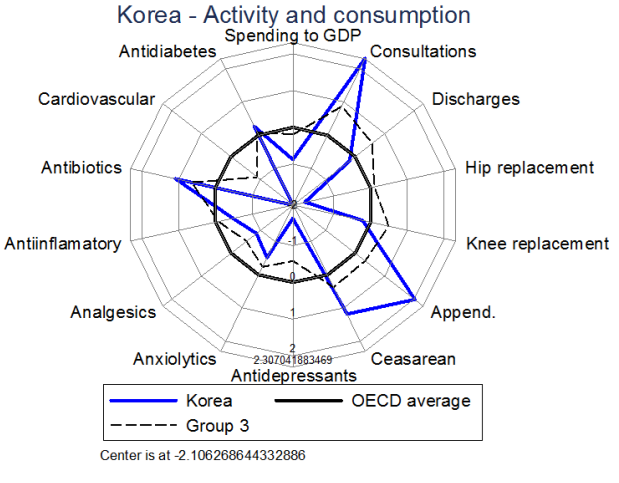
[18] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

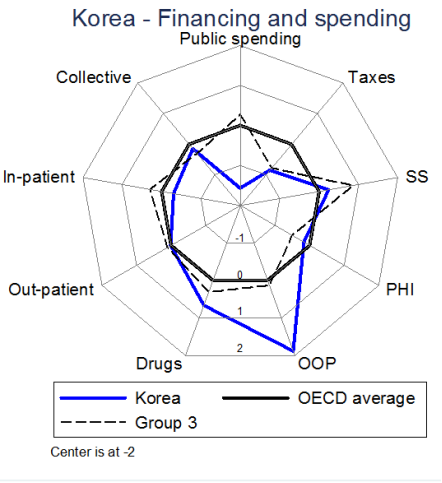
Figure A.20 - Health indicators: Korea, 2011 (or latest year available)[19]





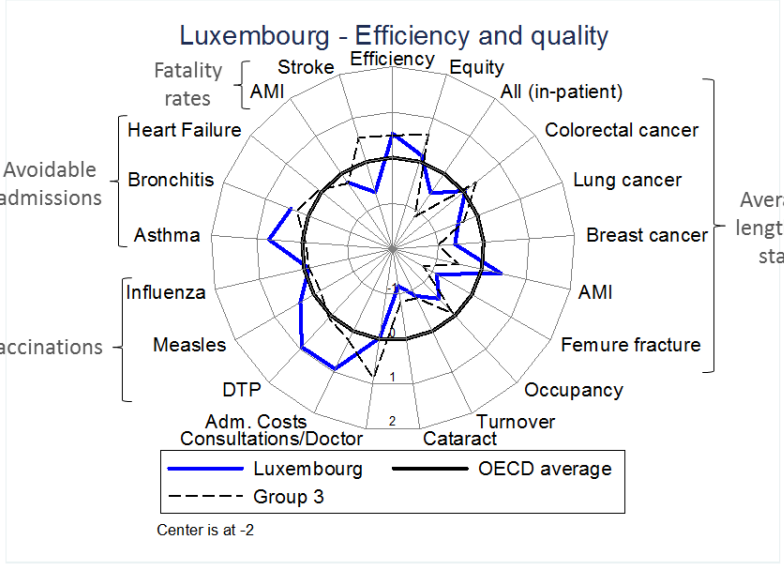


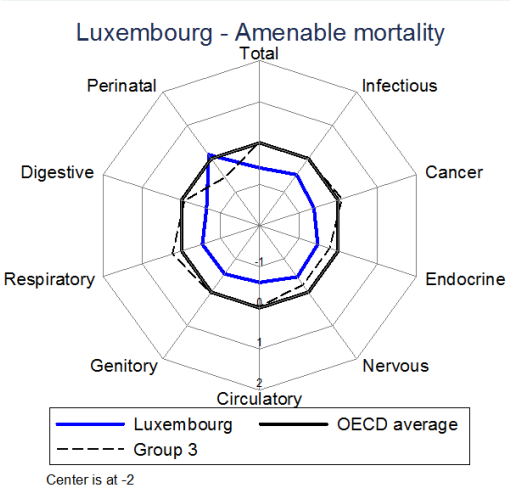


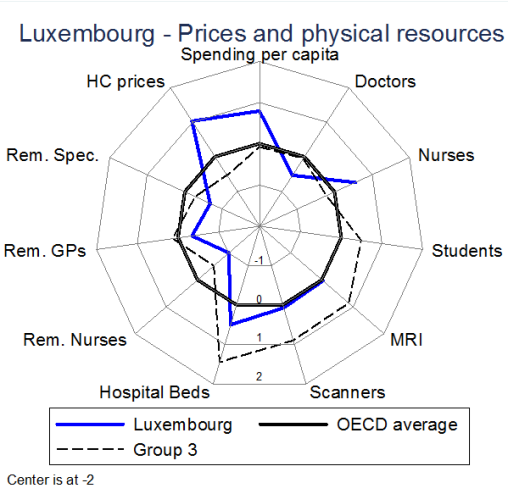


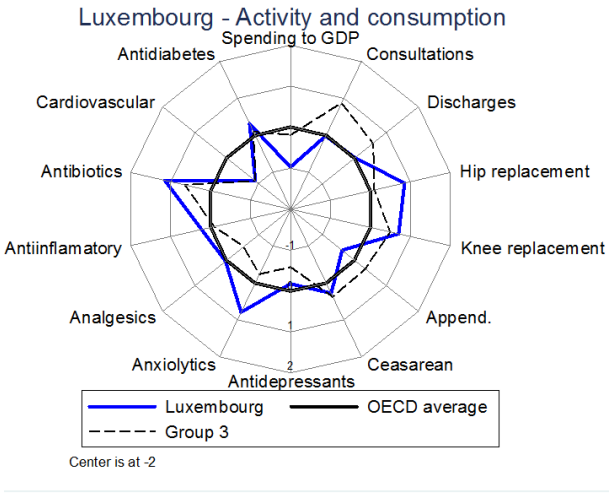
[19] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

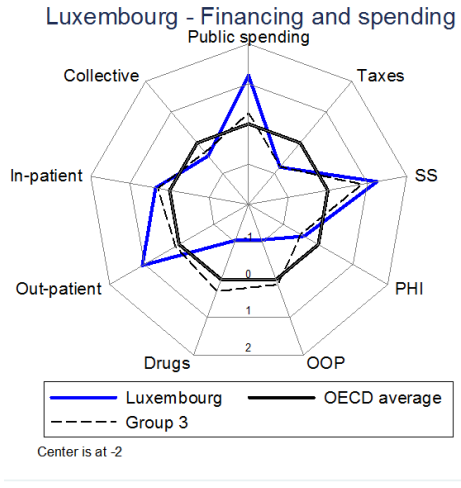
Figure A.21 - Health indicators: Luxembourg, 2011 (or latest year available)[20]





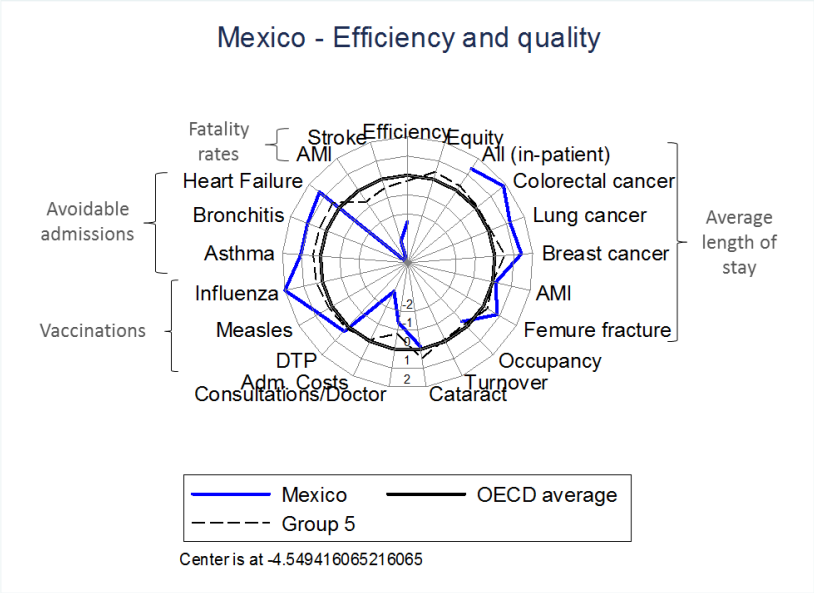


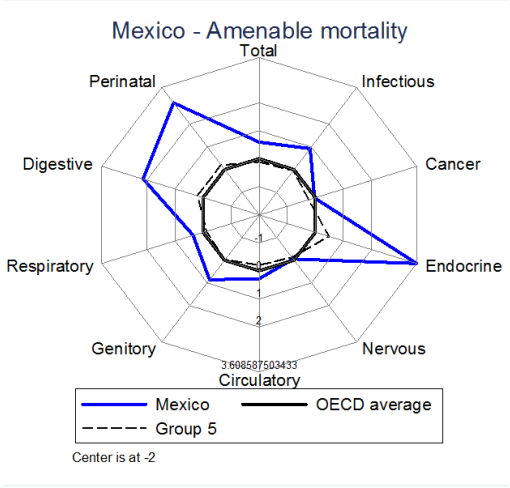


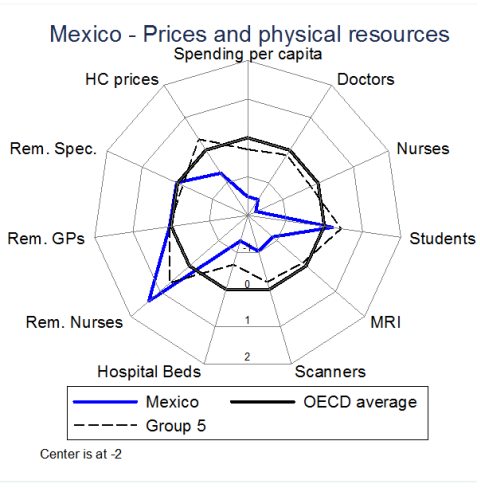


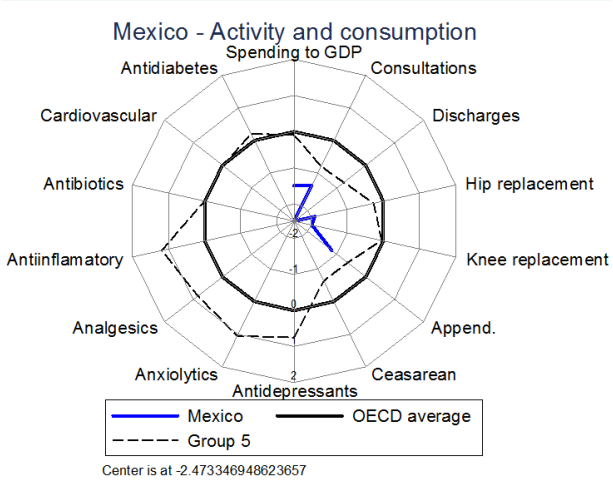
[20] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

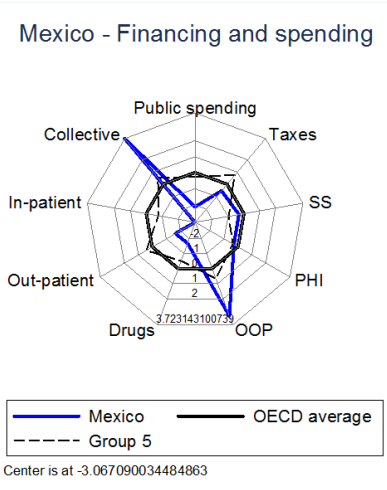
Figure A.22 - Health indicators: Mexico, 2011 (or latest year available)[21]





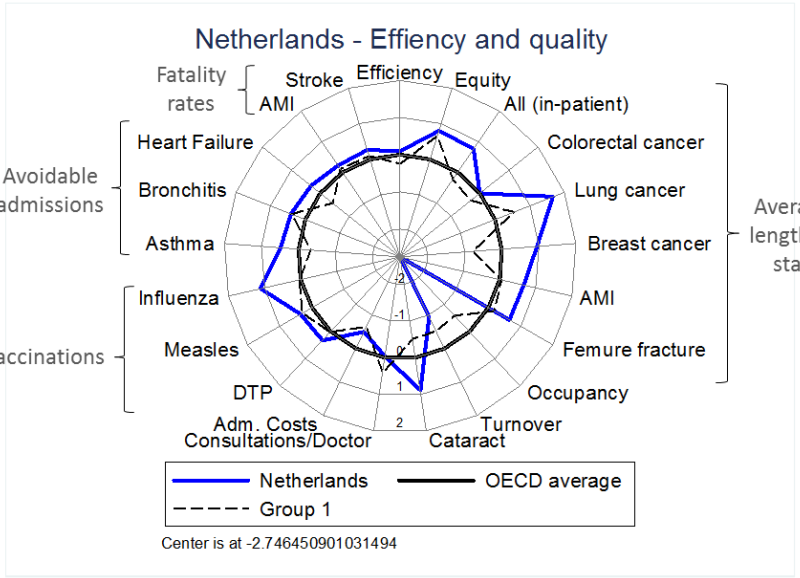


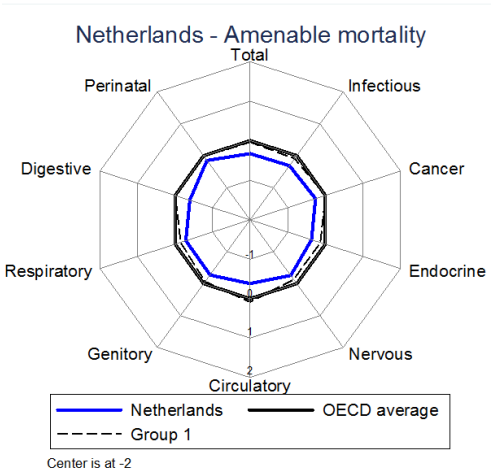


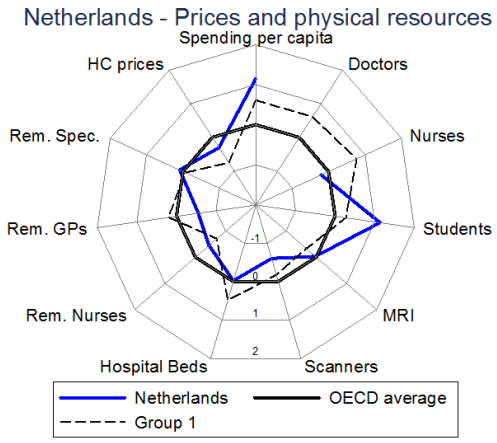


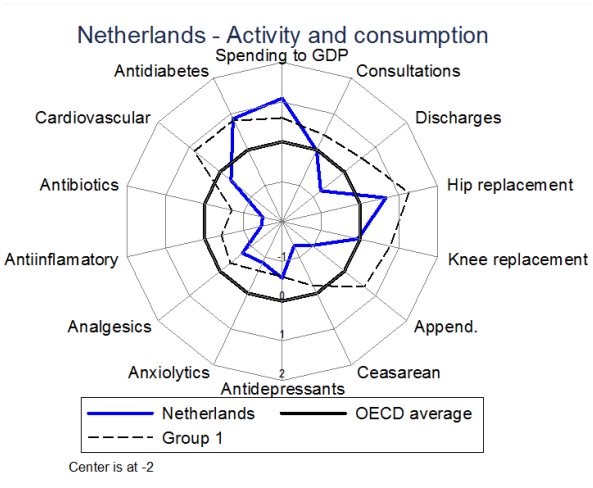
[21] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

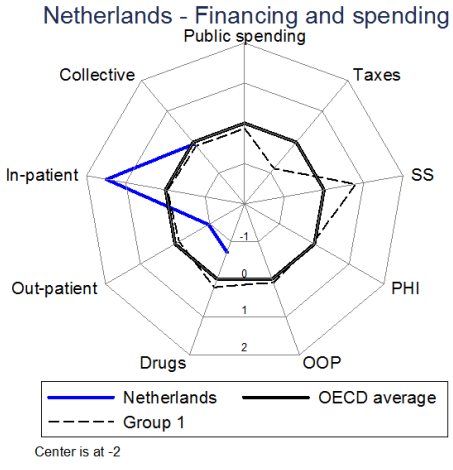
Figure A.23 - Health indicators: Netherlands, 2011 (or latest year available)[22]





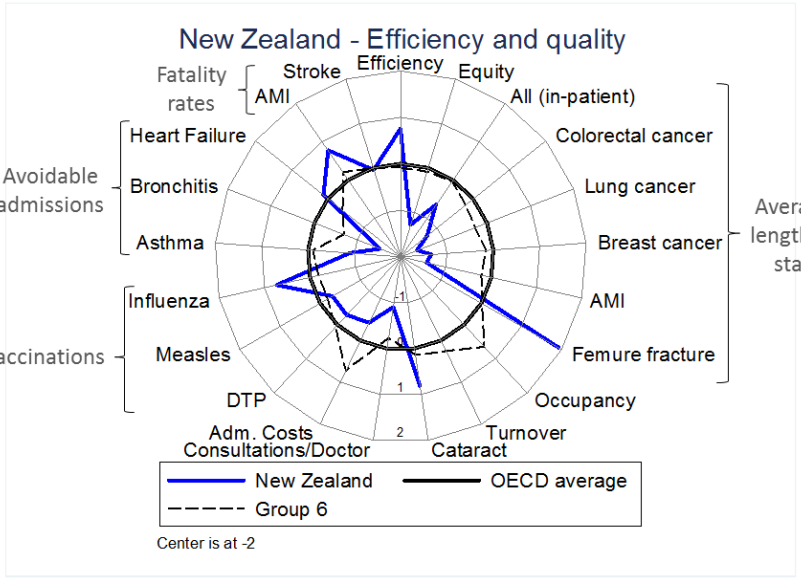


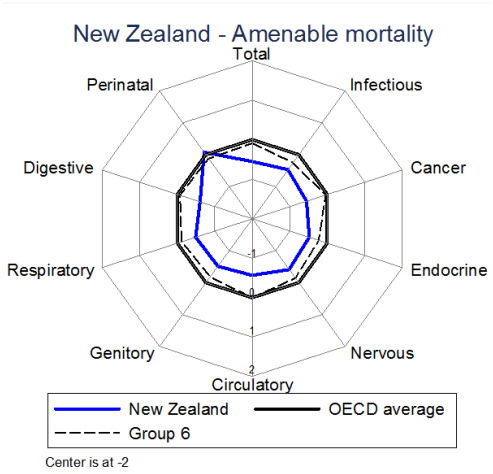


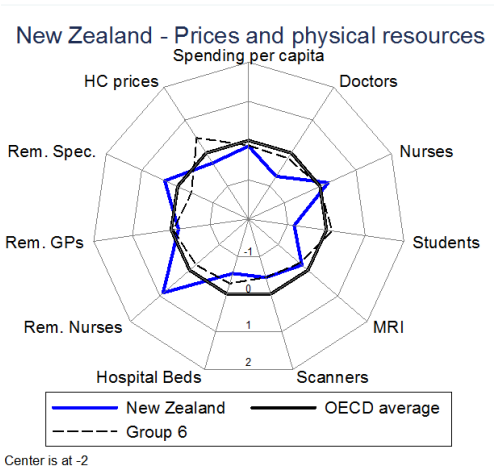


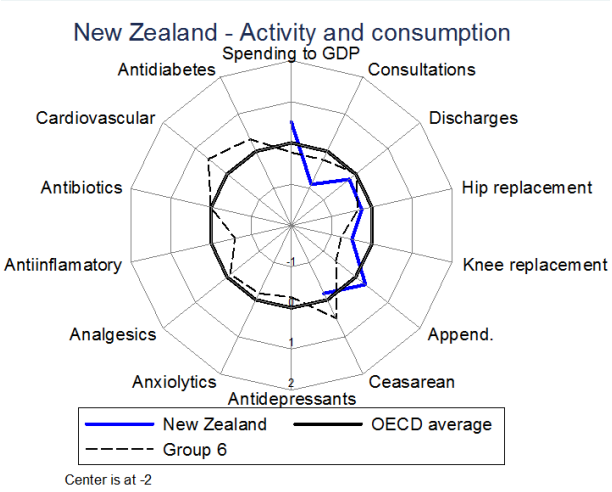
[22] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

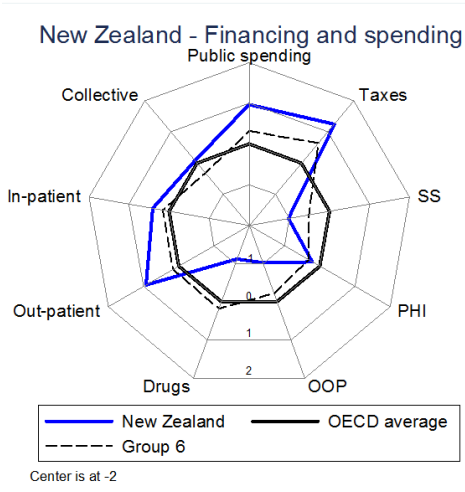
Figure A.24 - Health indicators: New Zealand, 2011 (or latest year available)[23]





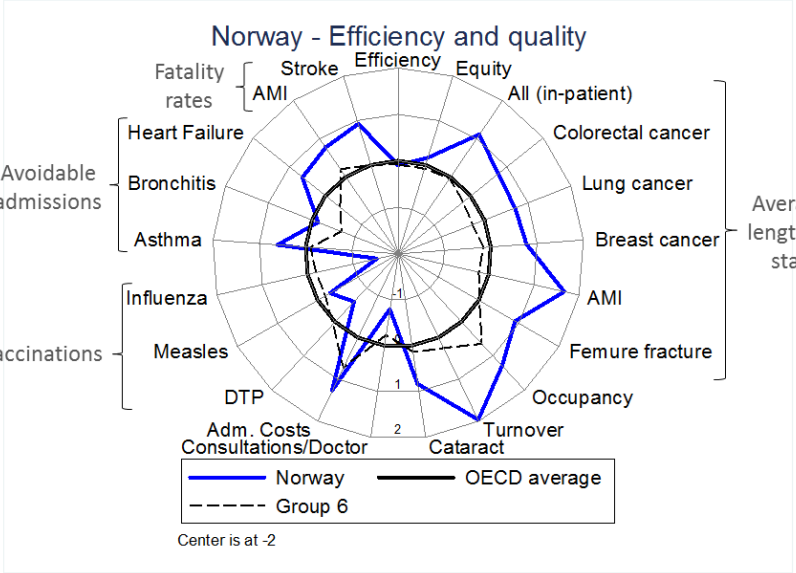


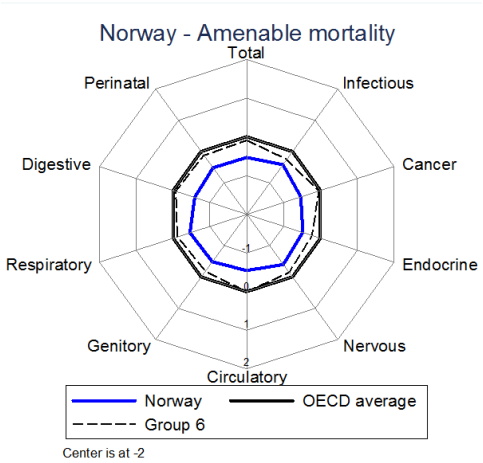


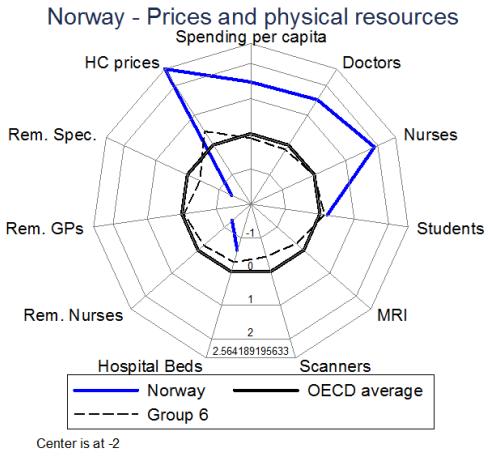


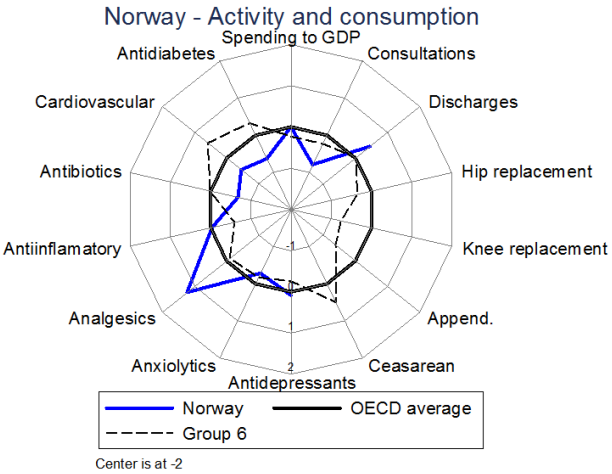
[23] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

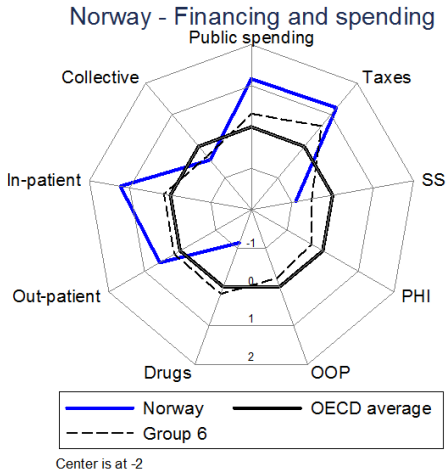
Figure A.25 - Health indicators: Norway, 2011 (or latest year available)[24]





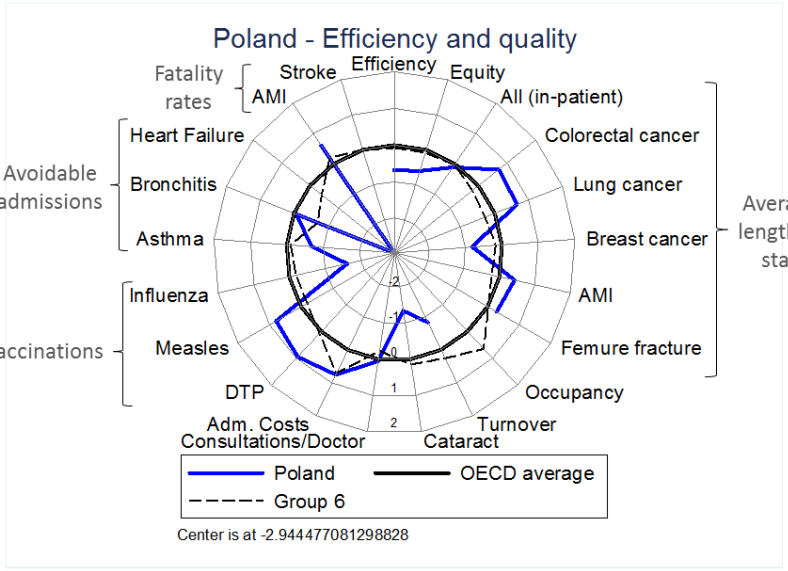


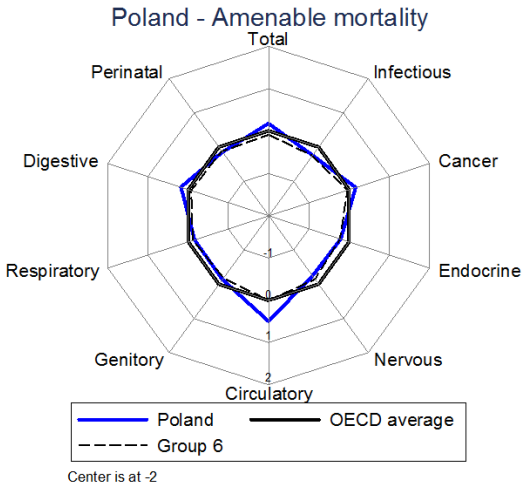


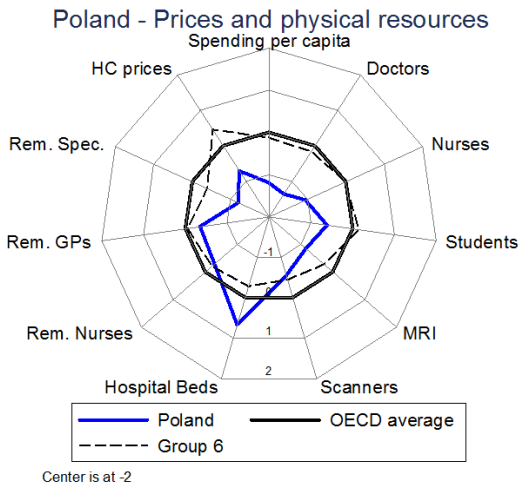


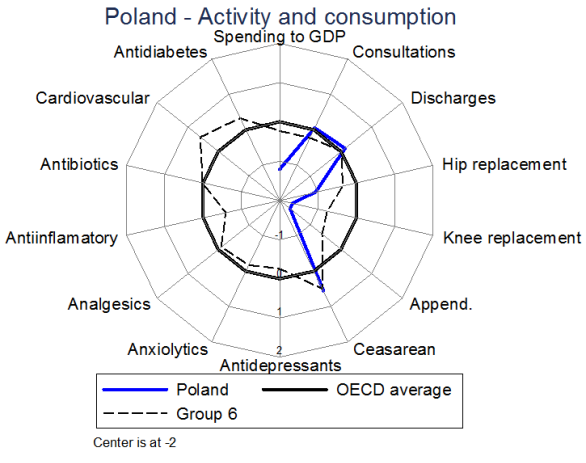
[24] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

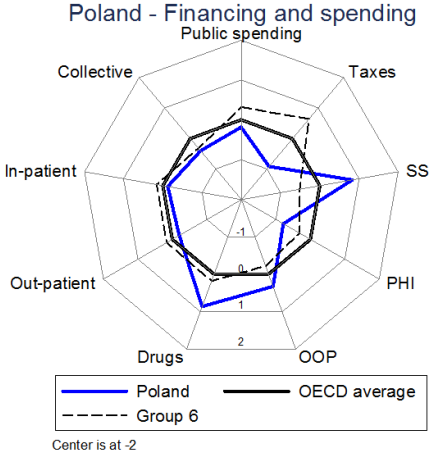
Figure A.26 - Health indicators: Poland, 2011 (or latest year available)[25]





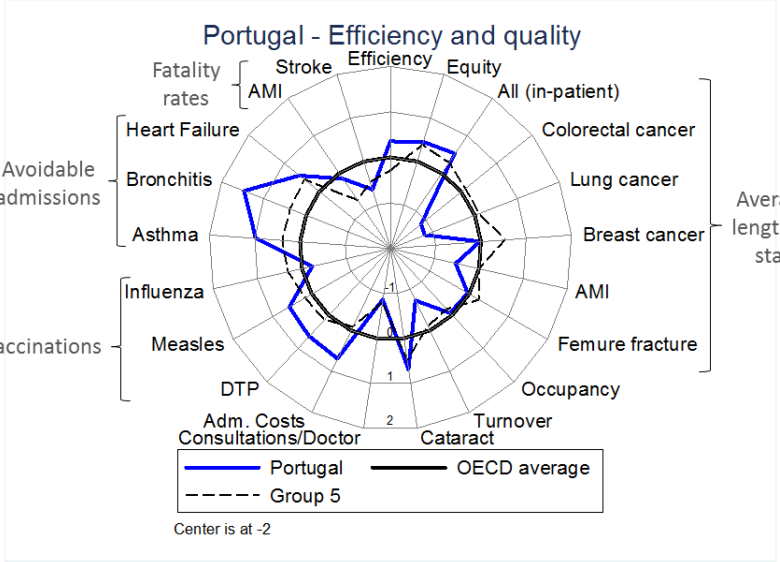


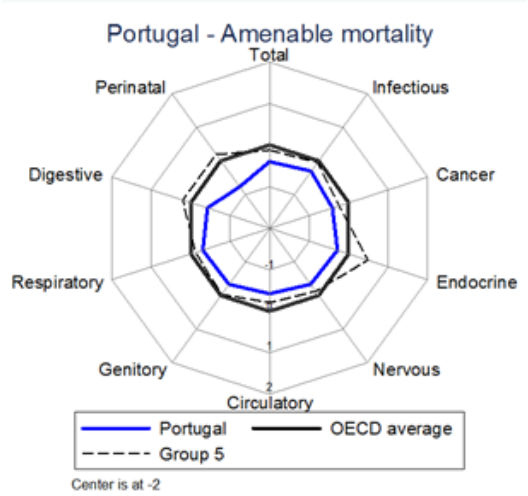


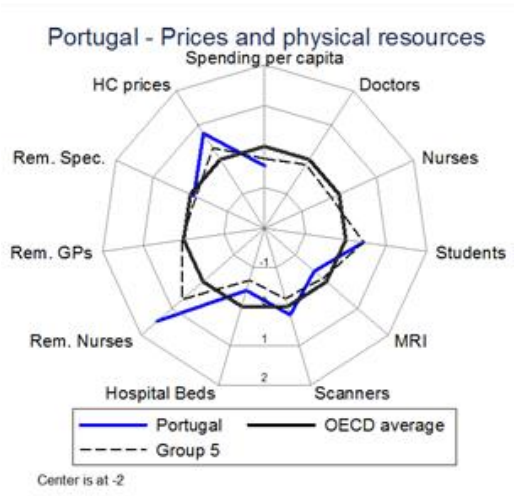


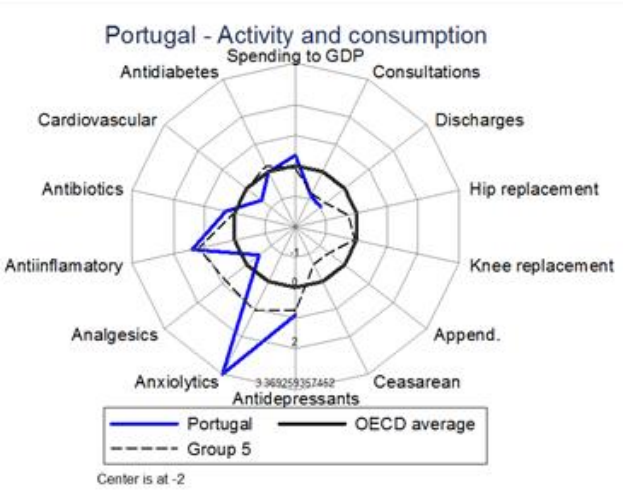
[25] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

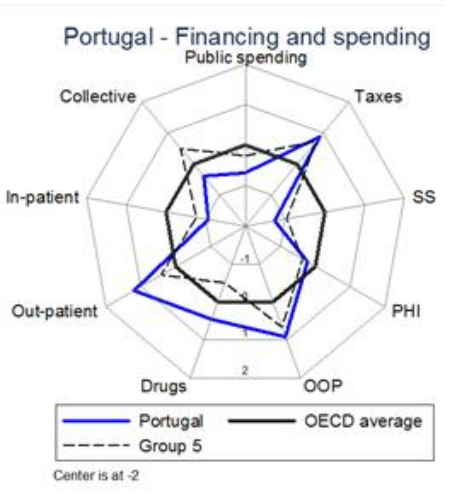
Figure A.27 - Health indicators: Portugal, 2011 (or latest year available)[26]





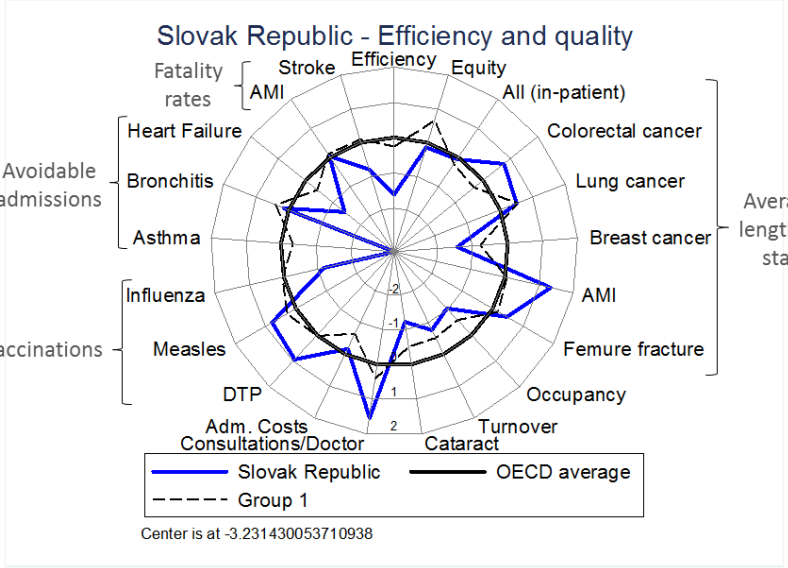


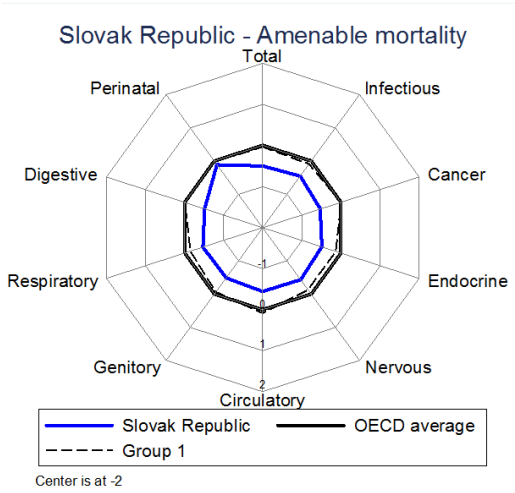


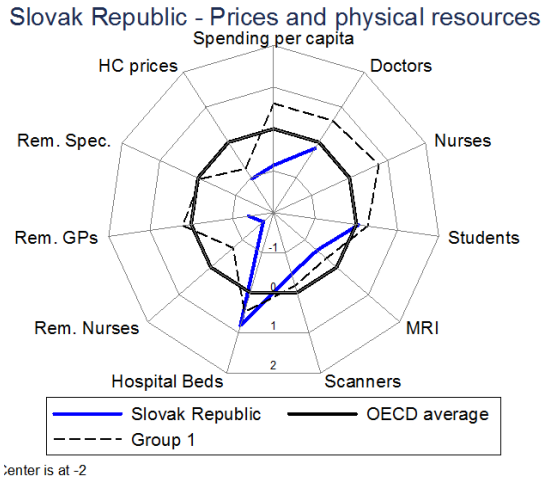


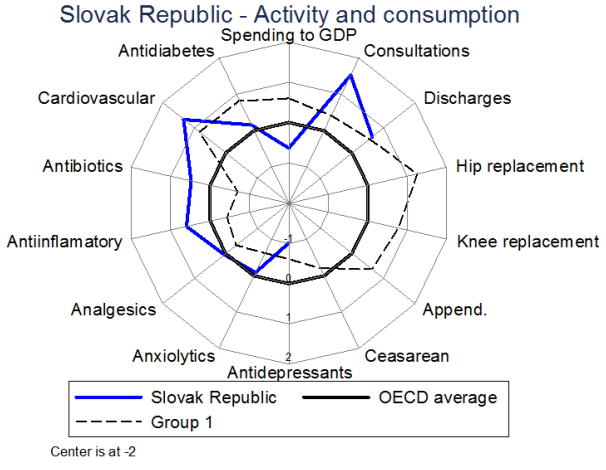
[26] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

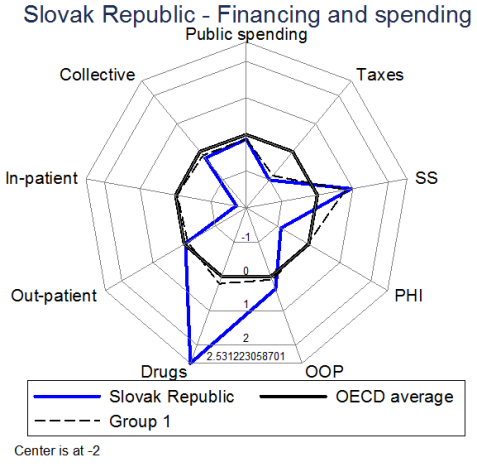
Figure A.28 - Health indicators: Slovak Republic, 2011 (or latest year available)[27]





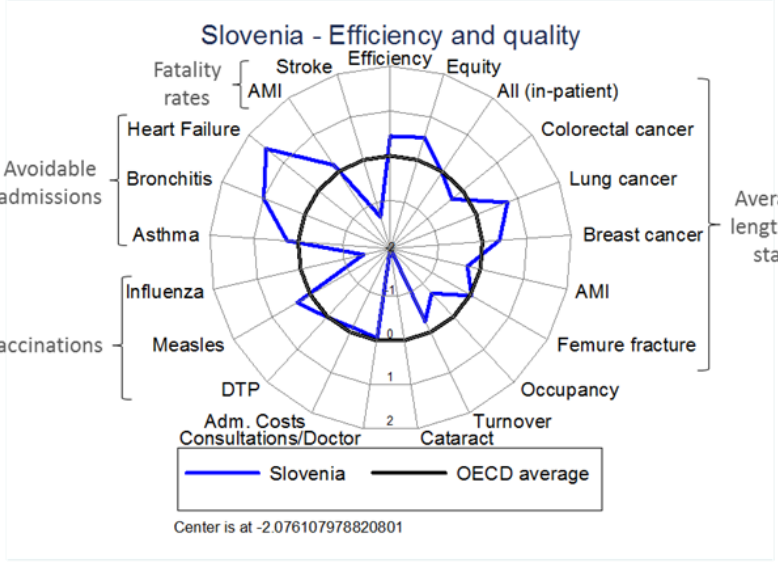


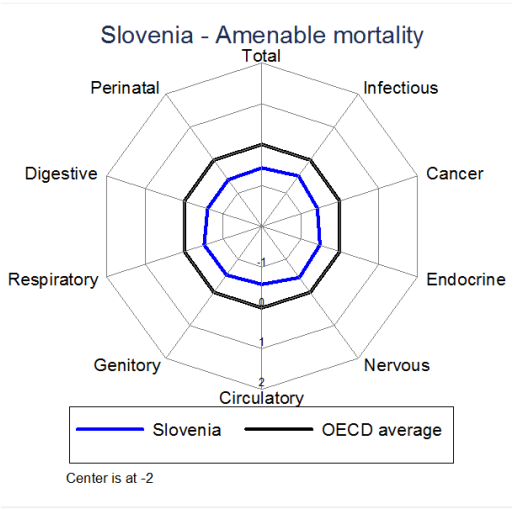


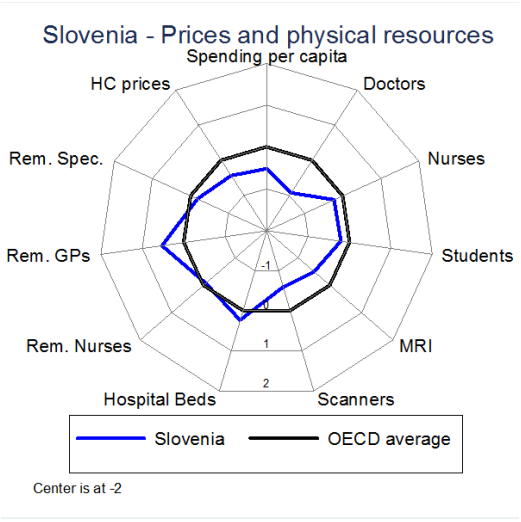


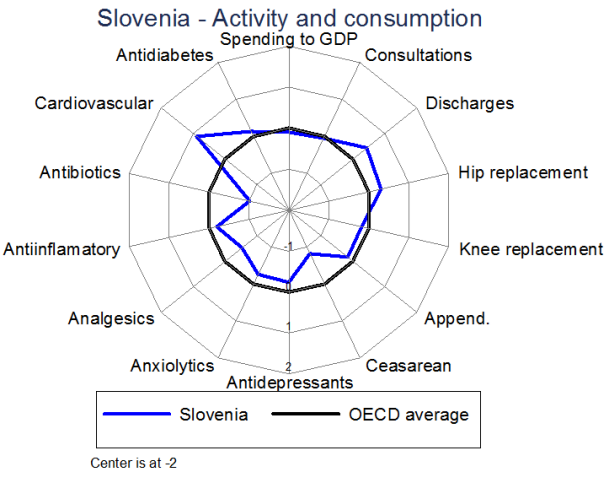
[27] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

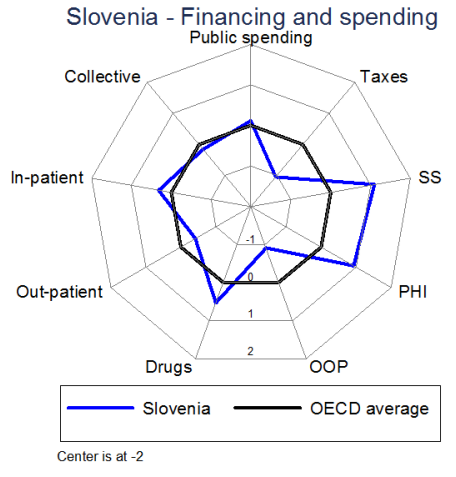
Figure A.29 - Health indicators: Slovenia, 2011 (or latest year available)[28]





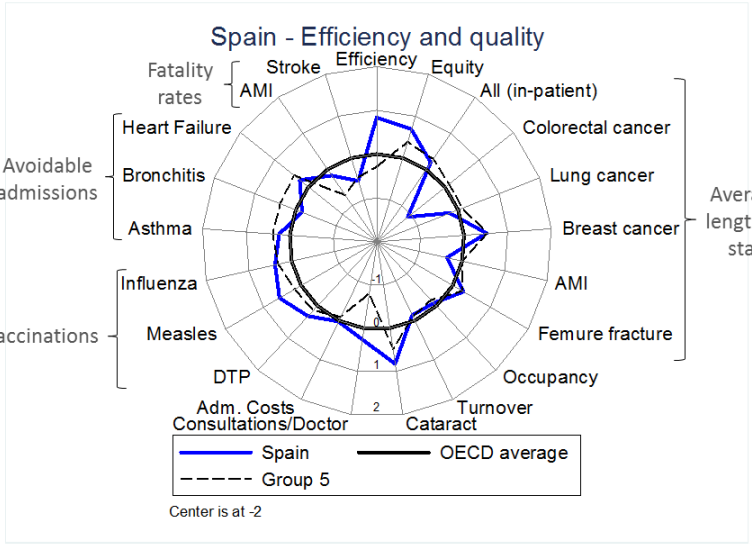


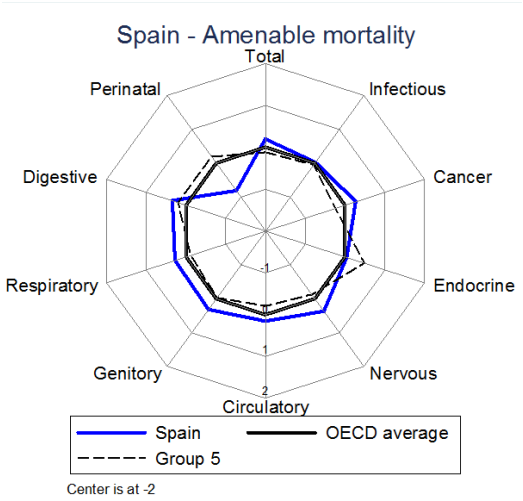


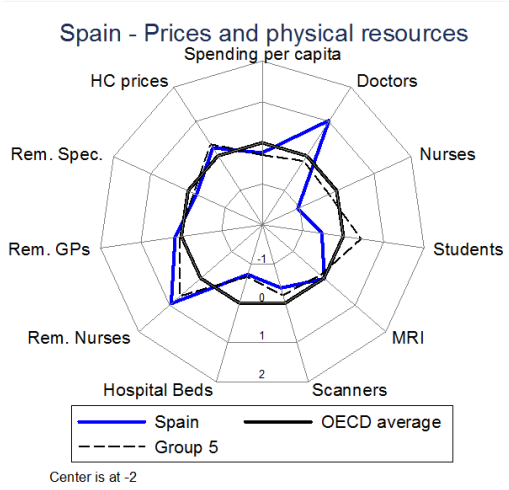


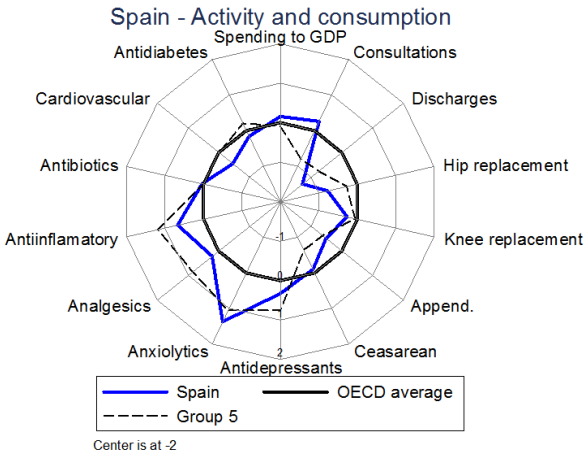
[28] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

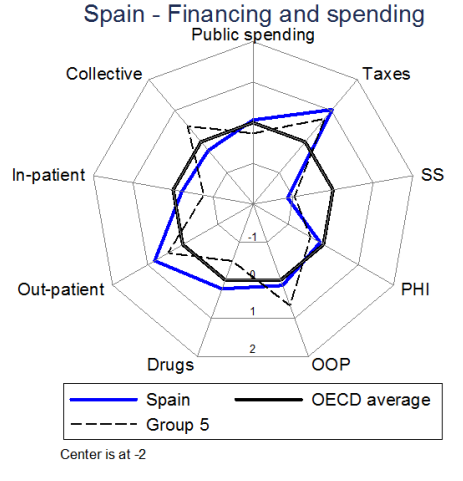
Figure A.30 - Health indicators: Spain, 2011 (or latest year available)[29]





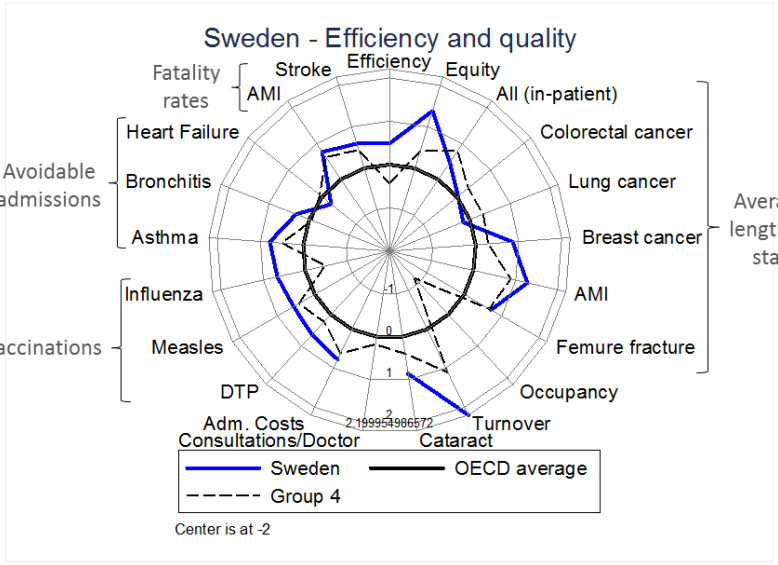


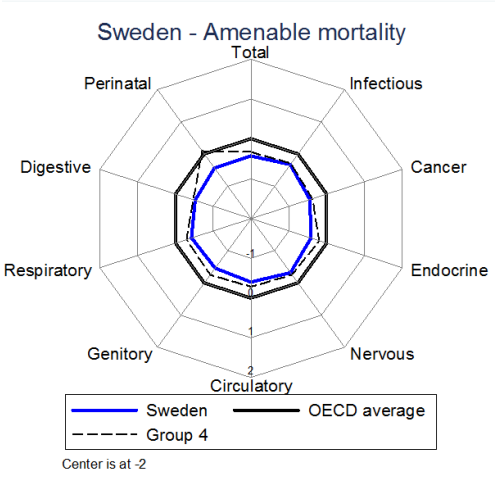


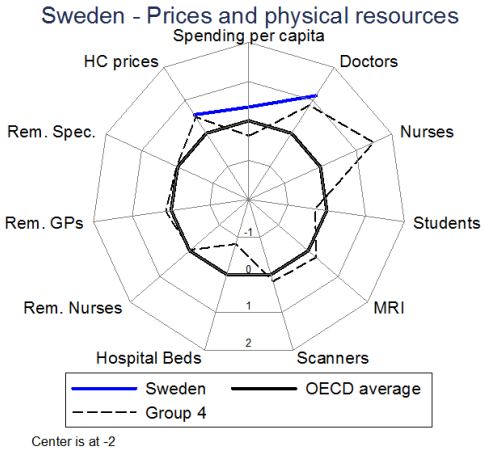


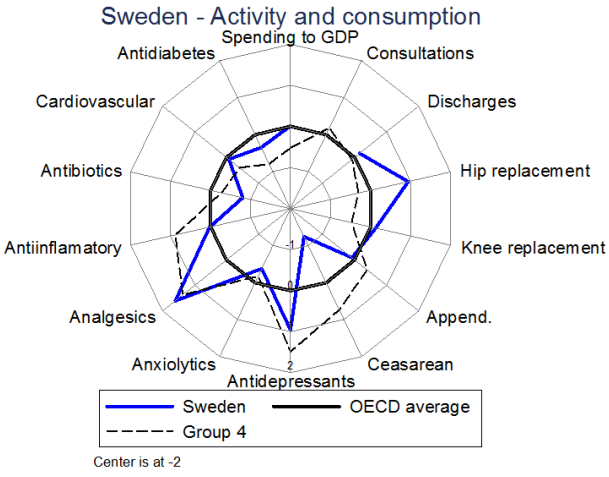
[29] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

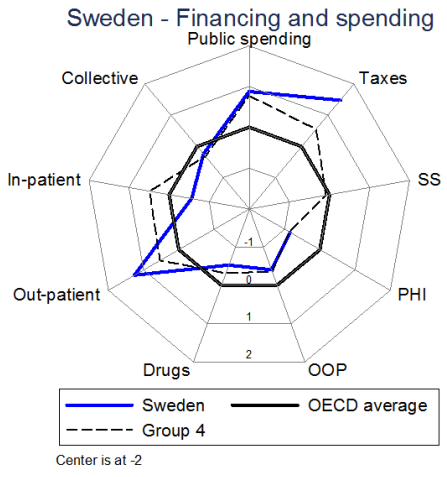
Figure A.31 - Health indicators: Sweden, 2011 (or latest year available)[30]





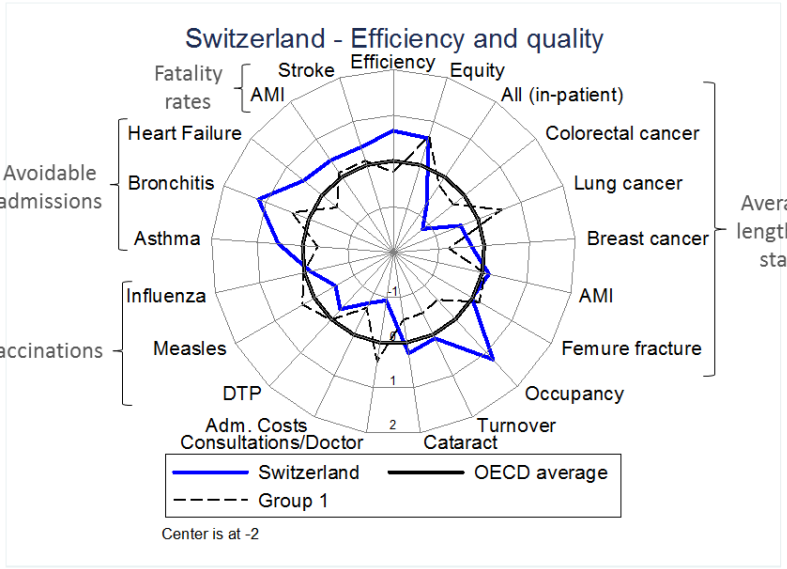


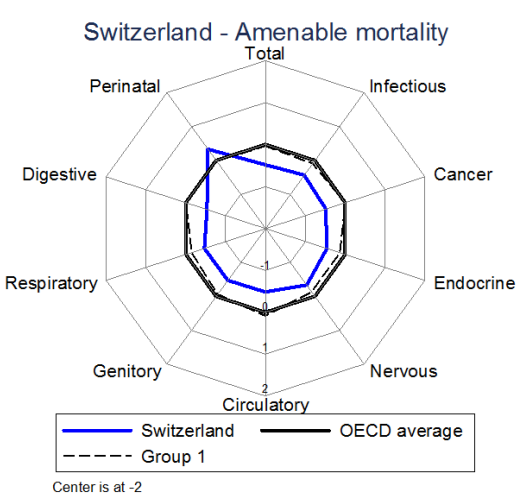


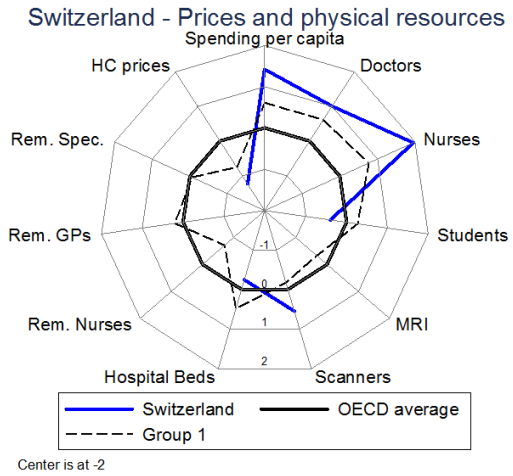


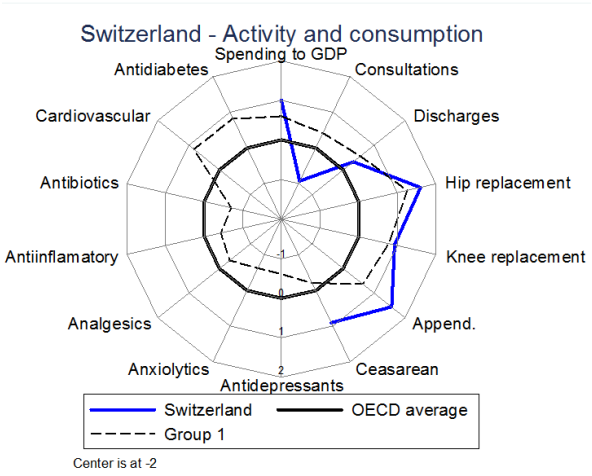
[30] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

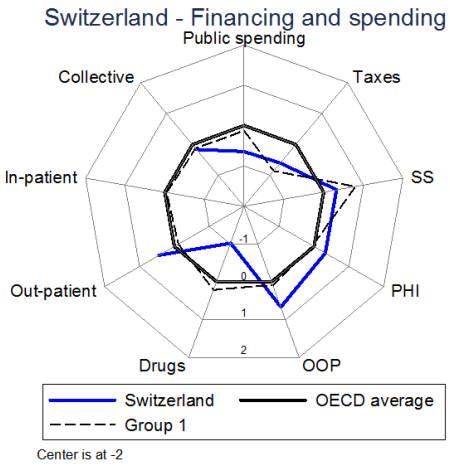
Figure A.32 - Health indicators: Switzerland, 2011 (or latest year available)[31]





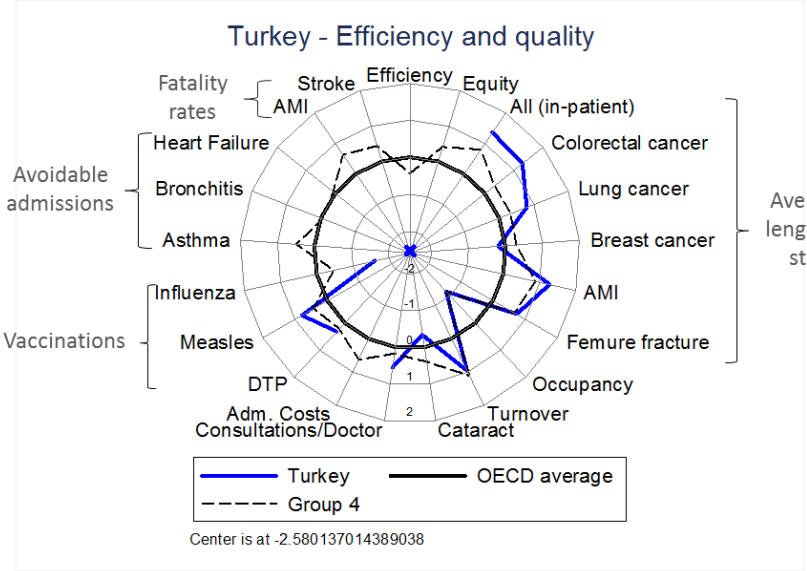


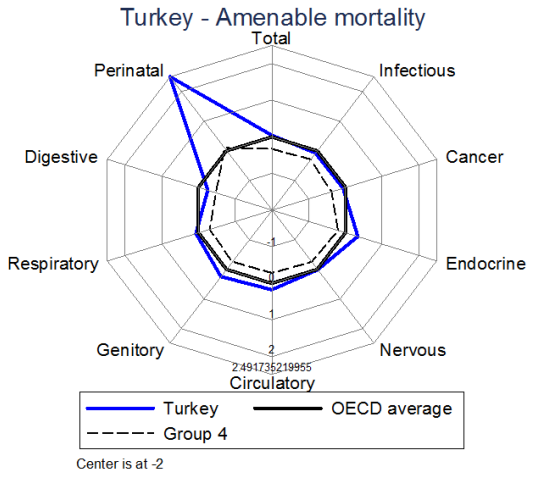


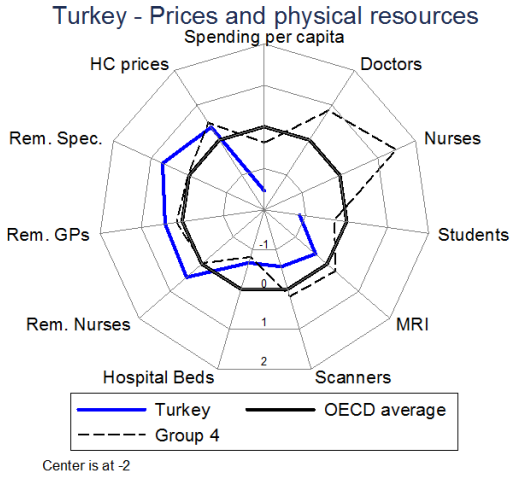


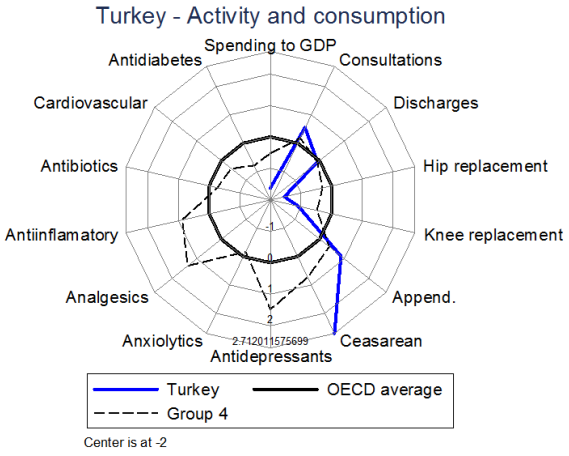
[31] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

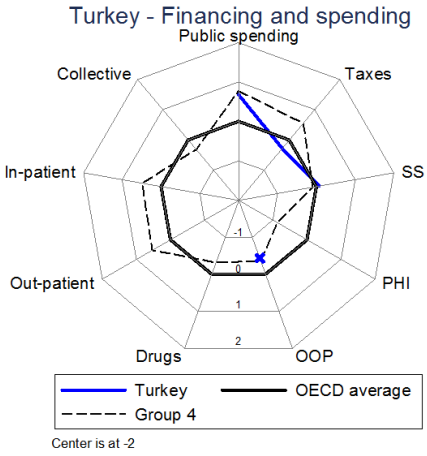
Figure A.33 - Health indicators: Turkey, 2011 (or latest year available)[32]





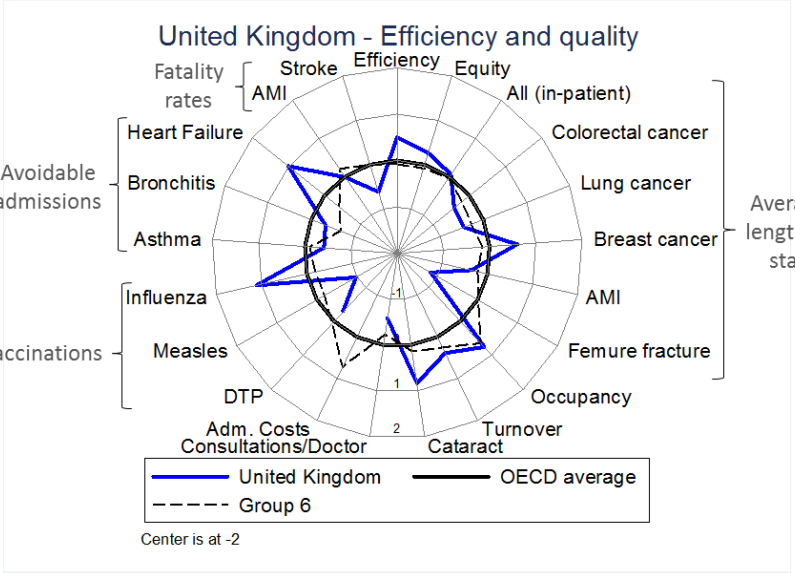


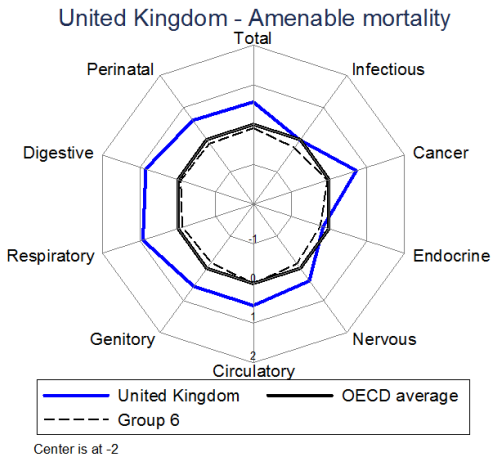


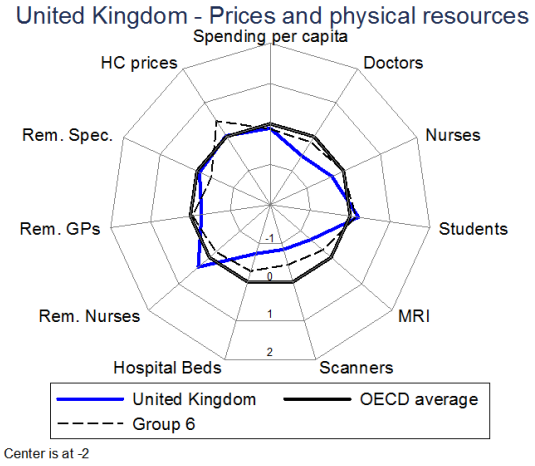


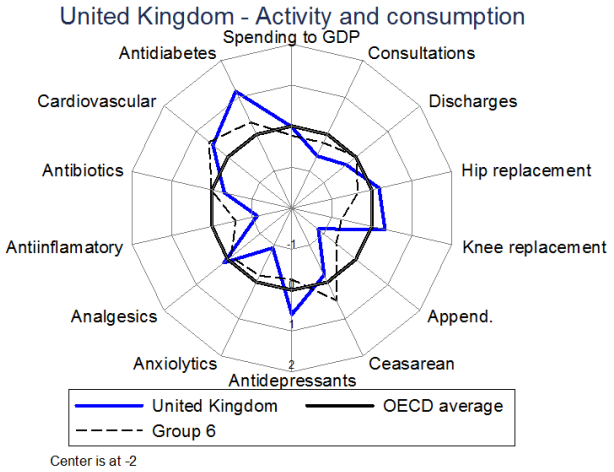
[32] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

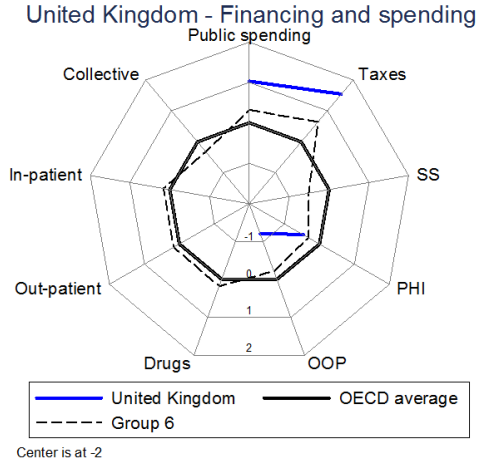
Figure A.34 - Health indicators: United Kingdom, 2011 (or latest year available)[33]





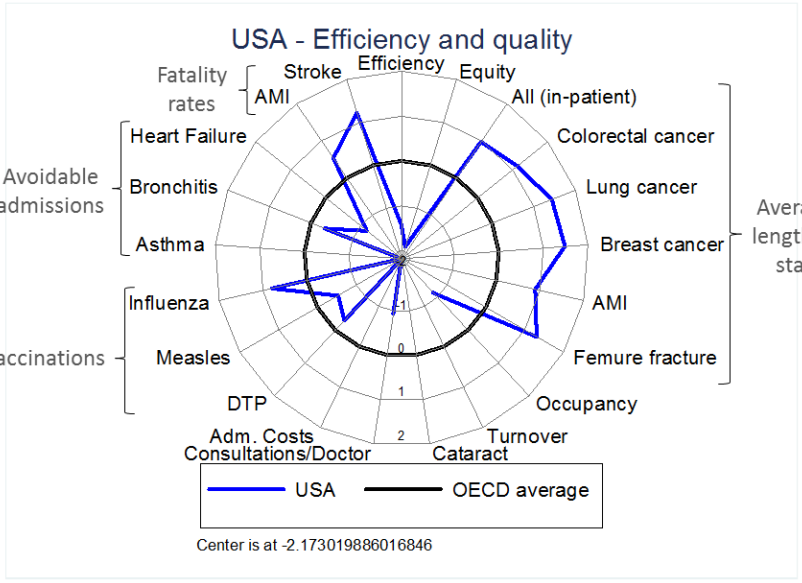


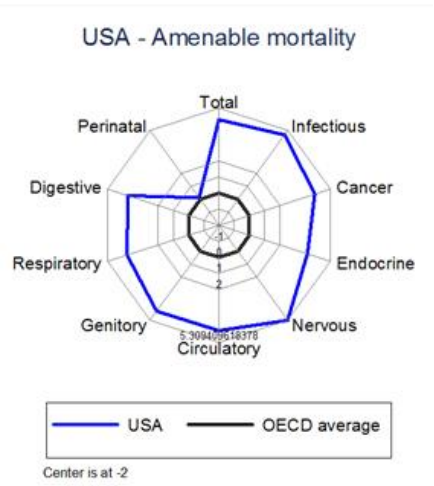


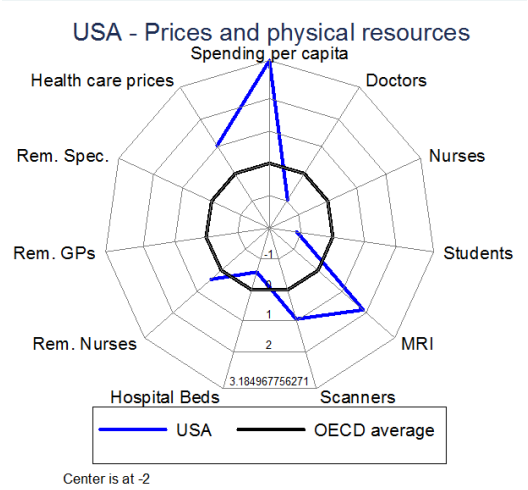


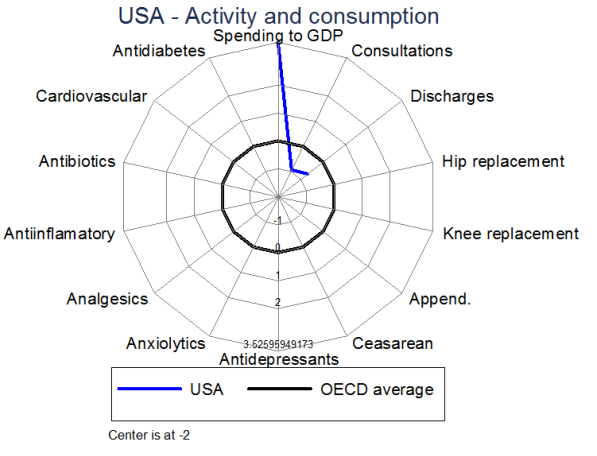
[33] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).

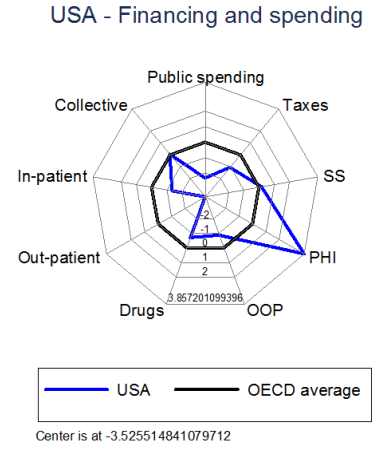
Figure A.35 - Health indicators: USA, 2011 (or latest year available)[34]











[34] In the graphs representing Activity consumption, Amenable mortality, Prices and physical resources and Financing and spending, the points outside the average circle mean that the indicators are higher than the OECD average. In the graph representing Efficiency and quality, the points outside the average circle mean that the country is doing better than the OECD average of that indicator (e.g. low fatality rates are placed outside the average circle; low administration costs are placed outside the average circle).